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NATIONAL MUSEUM
21 OCT 1932
VICTORIA

The JOURNAL of AGRICULTURE

Of The Department

VICTORIA AUSTRALIA

OCTOBER 1932 Price 3d.

Department of Agriculture

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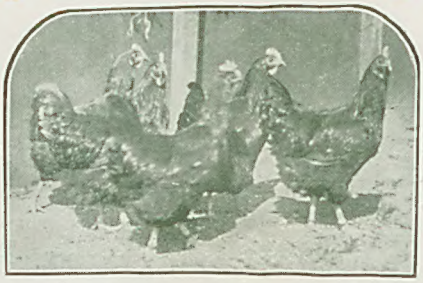

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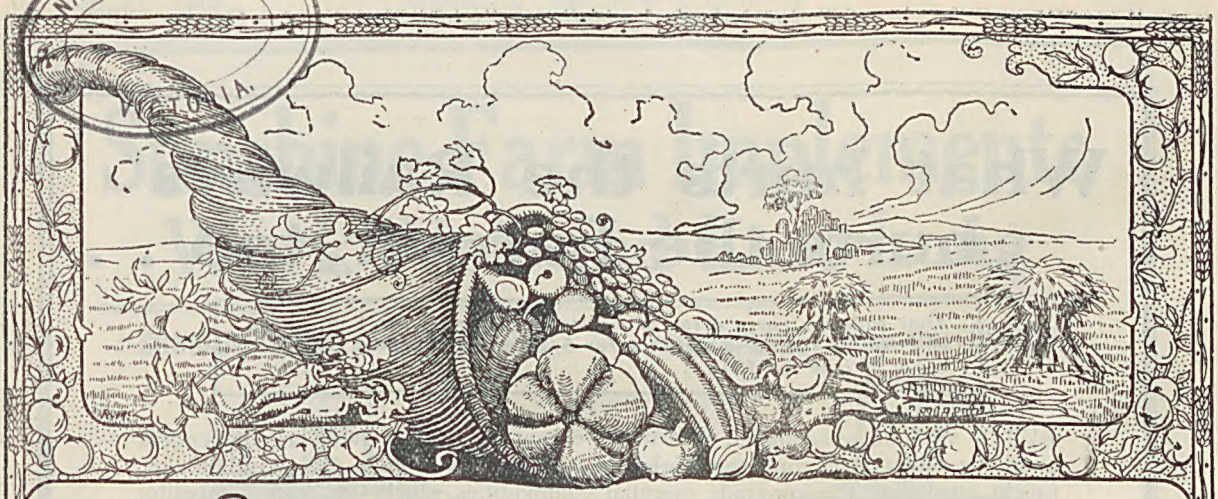

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Issued under the direction of the Hon. J. Allan, M.L.A., Minister of Agriculture.

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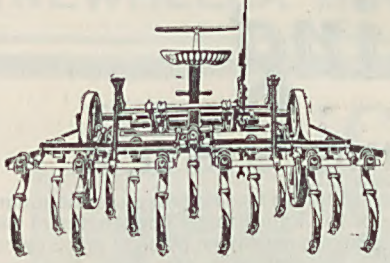

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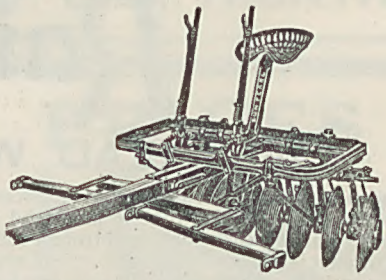

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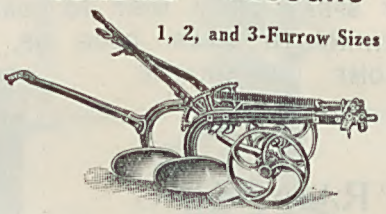

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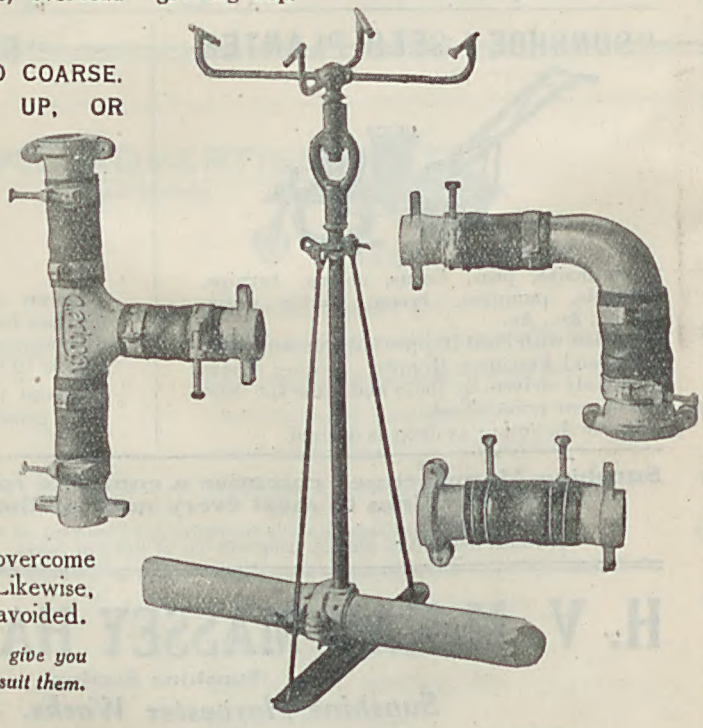

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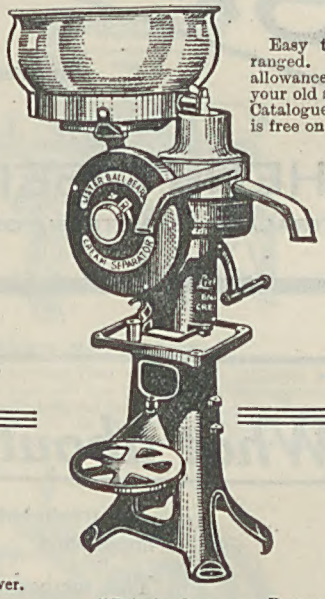

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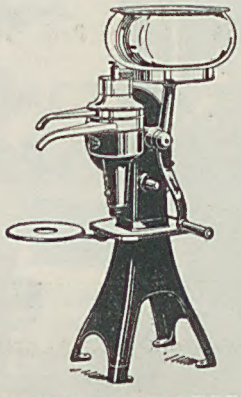

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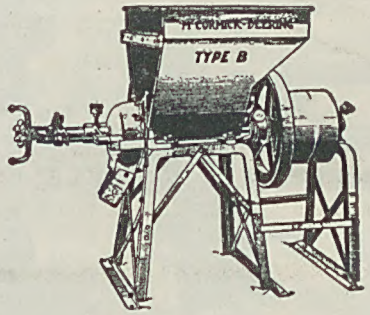

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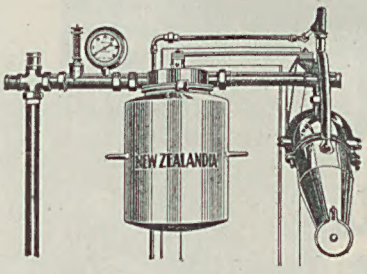

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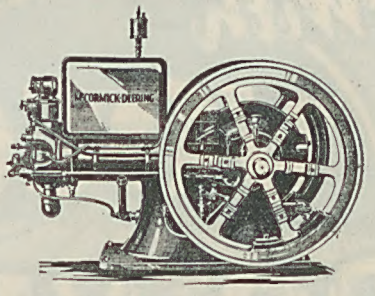

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With
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the one oil that always
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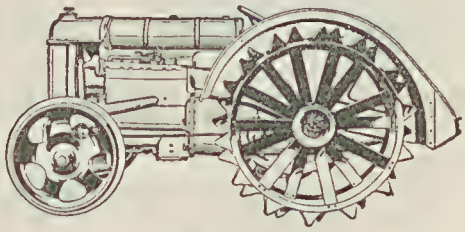
£50 Deposit! Balance over Two Crops



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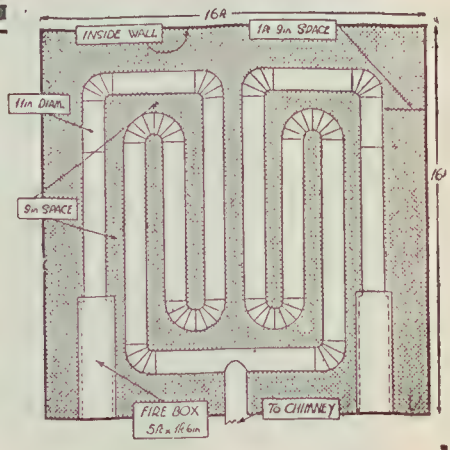

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The Journal of the DEPARTMENT of AGRICULTURE of VICTORIA

Werribee Research Farm

Farmers' Field Day

MORE than 600 farmers and others accepted the invitation of the Honorable the Minister for Agriculture, Mr. Allan, M.L.A., to attend the annual field day held at the Central Research Farm, Werribee, on September 23rd. The gathering included the Lieutenant-Governor, Sir William Irvine, representatives of the consulates of the United States of America, Switzerland, Italy, Czechoslovakia and Brazil, and prominent agriculturists from all parts of the State.

Welcoming the visitors, the Minister pointed out that the farm was established twenty years ago for the benefit of producers who, he was convinced, had gained much real benefit from the experimental and research work carried on there. The farm catered for every section of agriculture, but perhaps the most important of the recent work was the development in regard to sown pastures, particularly under irrigation conditions. The advances made in this direction had been greater than in any other branch of primary production, and in many parts of Victoria pastures were now carrying more than double the stock they were carrying a few years ago. He believed that the extension of the area under irrigated pastures would result eventually in doubling the carrying capacity of the irrigation districts.

A brief description of the progress of the Research Farm was given by the Director of Agriculture, Mr. R. Crowe, who stated that, when it was first purchased for the State, it was a bare wind-swept area. The methods adopted for restoring the fertility of the soil had enabled the Department of Agriculture to build up the splendid institution the farm now was. As a result of only one of the activities of the Research Farm huge sums had been placed in the pockets of wheat-growers—the adoption of wheat varieties bred at Werribee having resulted in increasing their returns by at least £800,000 per annum, while the railways were receiving £55,000 a year more for the carriage of the extra wheat. Other activities included the distribution of pure-bred stock, and already 466 pure-bred bulls and 37 Clydesdale horses had been sold to farmers. The poultry branch was doing splendid work in distributing high-producing stud birds, and it was interesting to note that a Werribee-bred hen had recently created a Victorian record by laying 337 eggs in the year.

Value of Research.

The value of scientific research was stressed by the Agricultural Superintendent, Mr. H. A. Mullett, B.Agr.Sc., who pointed out that one of the outstanding features of modern industrial life was the ease with which production in secondary industries could be increased. This was because those industries were sufficiently large to employ trained specialists for the specific purpose of improving production methods and eliminating waste. The fact that large rewards awaited industries and individuals successful in this regard provided the necessary incentive.

In agriculture, on the other hand, the units of production were small, consequently individual farmers could not afford to employ research workers, nor was there any valuable monetary reward awaiting any person who was able to solve a particular agricultural problem.

Again, when a new manufacturing process was discovered, it was rapidly adopted, but, in agriculture, because of the scattered nature of the units, and the fact that each was controlled independently of the others, ideas travelled slowly, and it was many years before a new discovery was universally adopted.

For these reasons Governments the world over had found it necessary to undertake agricultural research, to provide for the dissemination of new ideas, and to standardize the products of the farm. These were recognized as functions of the Government, even in countries where primary industries were of relatively less importance than was the case in Victoria.

One way of estimating the relative importance of industries, especially in times like the present, Mr. Mullett pointed out, was by comparison of the values of the commodities exported. Over the last five years Victoria's exports had averaged £33,000,000 in value. To that sum primary produce contributed £27,000,000; gold and specie, £4,000,000; and secondary industries, approximately, £2,000,000. The principal items making up the £27,000,000 of primary produce exported were:—

Wool	£11,700,000
Wheat	5,500,000
Butter, cheese and milk products	3,800,000
Hides and skins ..	2,600,000
Fruit	1,500,000
Frozen meat ..	1,200,000

Because of the paramount importance of these industries it was obvious that Victoria should have a well-equipped and thoroughly organized Department of Agriculture, whose function it should be to carry out research, disseminate the knowledge so gained, and to regulate the marketing of the produce.

A question that might well be asked, he continued, was as to the amount of success that had been achieved in the application of scientific research to agriculture. Several facts could be quoted in answer to such a question. For instance, wheats bred at Werribee were now sown on 66 per cent. of the 3,400,000 acres sown to wheat annually in Victoria. It had been proved beyond doubt that these newer varieties were yielding, on the avarage, at least 2 bushels per acre more than the varieties they had displaced, and, as they had just heard, the monetary value of this increase to growers was at least £800,000 a year. In respect to pastures it might be pointed out that top-dressing which was practised annually on 1,000,000 acres of grass land in Victoria deve-

A Section of the Crowd. ["*Australasian*" *Photo.*

loped as the result of work done at the Rutherglen State Farm, and the demonstration at Werribee of the value of English grasses under irrigation had been the primary cause for the present widespread development of sown pastures in irrigated districts. Again, work on the departmental test plots at Longerenong was the source from which originated the methods responsible for the wonderful increase in wheat yields in the Wimmera.

The Department, Mr. Mullett pointed out, had a great deal of research work successfully accomplished, but that was being put into practice only slowly. Perhaps the most important field for future development was in regard to pastures. Of the agricultural and pastoral produce exported from Victoria no less than £19,000,000 worth was produced from the grasslands of the State. If it were possible to place into immediate actual operation the results of the Department's researches that figure could be doubled. The limiting factor in increasing production was the speed with which farmers could be induced to adopt the most modern practices, and that work could not be done effectively without a well-equipped extension service operating through the Department of Agriculture.

Wheat Breeding Activities.

One of the primary aims of the farm, since its inception, has been to produce, by cross-breeding and selection, new varieties of wheat, oats and barley. The main objective has been the production of prolific and drought resistant wheats, suitable for the different districts of the State, and in this direction considerable success has been achieved. Last year 2,116,599 acres, or 66 per cent. of the wheat area in Victoria was sown with varieties which originated at the State Research Farm, Werribee. The rapidity with which these wheats have displaced the older varieties is indicated by the following table:—

Distribution of Werribee Bred Wheats.

Year.	Acreage Sown in Victoria.	Percentage Total Area.
	acres.	%
1925	66,000	2
1926	195,000	6
1927	507,000	16
1928	1,000,000	25
1929	1,480,000	41
1930	2,680,393	56
1931	2,116,599	66

Free Gallipoli raised at Werribee is now the most extensively grown variety, and last year 1,254,360 acres were sown with this wheat in Victoria, as compared with 232,591 acres of Federation, which for more than a decade held first place. Free Gallipoli is a mid-season variety, and has proved its adaptability to a wide range of conditions, a fact which is demonstrated by the following table showing the areas sown with this wheat in the various districts of the State:—

Distribution of Free Gallipoli, 1931.

District.	Acreage Sown with Free Gallipoli.	Percentage of Total Area Sown.	Order of Popularity.
	acres.	%	
Mallee	548,006	31	1st
Wimmera ..	433,499	53	1st
Northern ..	186,422	42	1st
North-Eastern ..	16,658	51	1st
Gippsland ..	1,107	6	3rd
Central	9,774	28	2nd
North Central ..	5,648	27	1st
Western	53,246	65	1st
State ..	1,254,360	39	1st

Free Gallipoli originated as a single plant selection from the variety Gallipoli in 1917. Having proved its superiority in the departmental plots throughout the State, it was distributed to farmers for the first time in 1923. Two years later 21,311 acres of the State were sown with Free Gallipoli, and within six years it had deposed Federation, which up till 1929 was the most extensively grown variety in Victoria.

Ranee, another variety bred at the Research Farm, is the second most popular wheat in the State, and this year 536,993 acres have been sown. It is an early midseason variety, particularly suited to the drier areas of the wheat belt; last season 371,708 acres of Ranee were sown in the Mallee.

At the State Research Farm, a later selection of this variety (Ranee 4 H) has as an average over a number of years, outyielded the original strain by 3.9 bushels per acre, and is the only one now being distributed.

Oat Breeding.

One of the major objectives of the oat breeding work is the production of drought-resistant, prolific varieties, and in this direction success has been achieved in the variety Palestine. This variety arose as a selection from a sample of oats gathered in Palestine during the war

Listening to a lecture on Fertilizers for Wheat. ["*Australasian*" Photo.

by Dr. T. Cherry. It is very short in the straw, and of very early maturity, and has proved itself suitable as an early grain oat over a wide range of conditions.

Dawn, another Werribee production, is also showing promise as an early-midseason grain variety. This new oat originated as a selection from the variety Sunrise, and though somewhat later in maturity than the parent, it is still earlier than Algerian in this respect. In addition, it is stronger in the straw than Sunrise, and in the green stage has proved particularly palatable to stock.

Attention is being given also to the production of superior hay varieties, and types suitable for early green feed.

Irrigation Investigations.

Permanent pastures now occupy a major part of the irrigated area of the farm. This development followed on the experience gained from the tests with grasses and clovers instituted when the farm was founded. As the lucerne thinned out, it has been replaced by sown pastures, because they have been found suitable for irrigated conditions, and are productive, long-lived, and palatable to stock. Pastures have proved much better adapted for grazing than lucerne.

The test plots laid down in 1925 comprise—

(*a*) Variety tests.
(*b*) Manurial tests.
(*c*) Rate and frequency of watering tests.

These tests correspond to those conducted with lucerne, but, whereas hay yields are a suitable measure of the production of lucerne under varied treatments, the production from pastures is not so easily determined. Determination of sheep carrying capacity and yields of herbage from close mowing at frequent intervals have now been adopted and promise satisfactory results.

In the "rate and frequency of watering" tests, six waterings each of 4 inches have given the highest yield, the best mixture of species and the best seasonal distribution.

A 2½-acre section has been laid out for an extension of the manurial tests on pastures, particularly as regards the value of nitrogen, and an area of ½ acre has been fenced off and subdivided into 43 plots. Every alternate plot receives sulphate of ammonia at particular periods of the year, and the influence of these dressings will be traced by mowing the grasses at the grazing stage. A complete report of these tests will be published shortly in this *Journal*. The evidence indicates the superiority of superphosphate as a top-dressing, and

(*Continued on page 504.*)

Pasture Plants of Victoria

Their Distribution in Relation to Climate

By F. R. Drake, B.Agr.Sc., Assistant Agrostologist, and J. E. Harrison, B.Agr.Sc., Senior Agrostologist.

INTENSIVE pasture development is taking place in Victoria, probably at a greater rate than at any previous time in our history. There is an acute realization that our national income is derived largely from animal products—wool, butter, and meat—and from that realization has emerged a serious interest in pastures as the main source of maintenance of our sheep and cattle.

The main objectives are increased production from existing stock and the carrying of increased numbers of stock. Undoubtedly both these objectives are economically and rapidly obtainable by the wider adoption of two principles already proved to be sound and reliable. These are—(1) the introduction of high producting pasture plants, and (2) the regular yearly use of manures on all pastures containing such plants. A third principle involving pasture management is under investigation and trial throughout the grazing areas of the State, but so far no definite formula can be laid down in respect of this, apart from the general statement that pasture plants should be grazed and rested alternately if they are to recover from each grazing and produce a maximum quantity of green, nutritious herbage.

It is the object of this article, by a discussion of the distribution and implied requirements of each important pasture species, to emphasize to farmers, graziers, and pastoralists the fact that the species most adapted to the climatic and soil conditions of any area will give the most satisfactory results in the long run. A clear appreciation of the limitations of a district in respect of pasture species is as necessary and important as an understanding of its possibilities. It is hoped that a perusal of these notes, which are necessarily brief, will encourage this outlook, and show that pasture improvement, as a State-wide undertaking, should be an orderly process, with every chance of success, especially in respect of a choice of species for each area, and, in fact, for each field of every farm.

The effect of Climate.

Climate, which is defined as the general average range of the weather, is worthy of detailed discussion, as being the main factor in determining the type of pasture plant which may be expected to flourish in any given locality. Rainfall is the most important factor, and temperature and humidity must be considered in so far as they affect plant growth and the effectiveness of the rain which falls.

The influence of climate on the evolution of plants is very great. There is a wide difference between the type of plant native to arid regions and that growing in humid regions. The life form or habit of growth of a plant may be taken as a reflex of the climate under which it has evolved and to which it is adjusted.

The daily life of a plant consists of a series of reactions to the ever-changing conditions of weather to which it is subjected. In a similar way, in its yearly life cycle can be traced the effects of the changing seasons. Provided the supply of water and plant foods is adequate, the rate of growth of a plant increases as the temperature rises. There is a minimum temperature, different for different species, below which a plant makes no growth, and temperatures considerably below this may even result in the death of the plant. Above this temperature active growth takes place, but with increasing temperatures and length of day the evaporating power of the air rises, and plants require more water if they are to maintain their rate of growth. The water requirement of a plant increases also with its size and with the amount of leaf it carries.

Conditions are very suitable for maximum growth during the rainy season of tropical countries or during the summer in districts where irrigation is practised, as in various parts of Victoria. If, however, the water supply is inadequate, growth is necessarily limited, and the plant will be forced into a dormant condition or may die.

Most plants have in their heredity characteristic periods of activity and rest coinciding with the favorable and unfavorable seasons of the climate under which they have evolved. A plant native to a country with a mild moist summer may be expected characteristically to make summer growth, and, if we attempt to grow it in a country with a hot, dry summer, it will be unable to observe its natural habit, and will succumb to the unusual conditions. In a similar way, plants native to a country with a long, cold winter may be unable to respond to warmer winter and spring conditions in another country. A long winter resting period is a fixed characteristic of the plant which it may not overcome. An example of this is seen in Grimm lucerne, which makes practically no winter growth, and is a low producer under Victorian conditions. This is one of the strongest arguments in favour of using, when possible, locally-grown seed of long established stands of grasses, clovers, and other fodder plants which have been culled and selected by our own climate.

In Victoria, except for the wettest areas, there are normally two resting periods in the year—mid-summer and mid-winter—determined by drought and cold respectively. Maximum growth occurs in the spring, and coincides with the chief warm rainy period. This occurs again to a lesser extent in the autumn, giving two periods of active growth and two periods of comparative inactivity.

As has been suggested already, it is these resting periods that are likely to be the danger points in the life of a plant. The Victorian winter is mild compared with that of most European countries, and it is seldom that soil temperature remains for any considerable time below the minimum required for growth. The temperature does become sufficiently low to reduce plant growth to a very low ebb, but very rarely is it low enough to cause the death of any but tropical plants. The summer period, on the other hand, may be one of considerable severity in point of high temperature and lack of rainfall, and it is with the ability or otherwise of the various pasture plants in common use in Victoria to survive this period that we are chiefly interested. Annuals, or plants living only one or part of one year, have adopted what is perhaps the most effective method of tiding over adverse periods. They die off after setting seed, and carry over in a completely dormant state as seed, germinating again with the first autumn rains. Many of the most successful introduced pasture plants in Victoria are annuals. Their success, measured by the rate at which they have spread and the amount of territory which they occupy, is due largely to the way in which they are adapted to our climate. In their early stages of growth they are soft and palatable and usually highly nutritious, and have therefore a very definite value in our pastures.

In perennials, or long-lived plants, some vegetative portion of the old plant must remain alive throughout the year, even if little or no growth is made at some stages. The native Victorian perennial grasses found growing in the drier regions all have certain characteristics in common. They are deep rooted, sometimes with creeping underground parts and with tough stems. The leaves are narrow, not numerous, and sometimes inrolled, thus reducing the loss of water by transpiration. They are capable of responding to any rain that falls during the summer, but also of remaining dormant during long periods of drought. However, most of the species which are used in the sowing down of new pastures are of a different type, being more succulent and leafy, and normally making more or less continuous growth through the warmer months and without the same capacity for remaining dormant through long dry periods.

Many of these plants have become naturalized in Victoria, but their spread has been confined to the more humid areas. In the most favoured localities old established pastures of introduced grasses and clovers consist almost wholly of perennial species. Moving towards drier districts, where the stress of the summer period becomes greater, the perennials tend to give way to annuals, and the introduced pastures consist of mixtures of perennials and annuals, the proportion of each depending mainly on the climatic conditions and also on the amount of re-seeding which is permitted. Finally, in the driest regions the pastures consist entirely of annuals, or where the land has not been broken up, either purely of native perennials or a mixture of these with annuals, both native and introduced.

Victorian Climate.

In a discussion of the distribution of pasture types, it thus becomes apparent that the adaptations of introduced and native species must be considered mainly in relation to the climate of the State, though the soil itself may be very important. The climatic and soil requirements of the more important pasture

species will be indicated later, and in order first to appreciate the significance of their distribution in old pastures in the various districts, an outline of the climate of Victoria is necessary, and will be undertaken with special reference to the summer months, which comprise the critical period in the life of introduced pastures.

Victoria, although but a relatively small corner of the Commonwealth, has a climate of great and often sudden changes. The hilly and mountainous country receives invariably the heaviest rainfall, the plain country the lowest. We have the Great Dividing Range, reaching considerable heights in the east, and descending to lower ranges and foothills in the west, and receiving in its more elevated parts a very heavy rainfall.

To the north of the Divide the country is level, forming a large trianglular plain, with a general slight fall towards the north, and sheltered by the Great Divide from rain-bearing winds. This plain is moderately to very dry, with high summer temperatures and a rainfall of considerable variability—these conditions being accentuated in the N.W. Mallee.

To the South of the Divide, rainfall is generally more abundant, particularly so near the coast, where it is also more regularly distributed and more reliable. The wettest southern regions are the Otway Ranges and the hill country of South Gippsland. There is a small area of plain country around Sale, having a light but well-distributed rainfall; further east the country again becomes hilly, and the rainfall rises, producing a very excellent climate, with a mild winter and abundant summer rainfall without excessively high temperatures.

West of Melbourne and south of the Divide the country is chiefly flat, with a dry central area sheltered by the Otway Ranges and the Grampians; but the coastal regions are moderately wet. Further west still, the rainfall varies in proportion to the distance from the coast, but West Victoria does not enjoy the good summer rainfall of Gippsland, especially East Gippsland.

In considering the climate of any locality, the average annual rainfall is the figure most commonly quoted. In the Average Rainfall Map of Victoria (Fig. 1) the lines or isohyets pass through districts having equal rainfalls and of a value shown at the extremity of each

Fig. 1—Map of Victoria, showing the Average Annual Rainfall.

line. It is seen that, in a general way, the rainfall decreases as one goes away from the coast, but that even in coastal regions there are very considerable differences between the rainfall received at localities separated in many cases only by a few miles.

These variations are due chiefly to differences in elevation or topography. Elevated coastal regions invariably receive heavy rainfall, while exercising a sheltering effect on areas to their leeward side. The most striking instance of this sheltering effect is seen in the volcanic plain in the Western District. If the 25-in. isohyet is followed, it is seen that just east of the Grampians it commences to run south, and shows a loop encircling a large area of flat lowlying country extending from Bacchus Marsh to Ararat. All this country has an average rainfall of under 25 inches. The 25-in. isohyet divides the State into two very nearly equal halves. The portion having a rainfall above this amount is commonly known as closer settlement country—the higher rainfall permitting of more diversified agriculture than is possible in the drier areas.

Fig. 2.—Map of Victoria showing Variability of Rainfall.

The index numbers show the average deviation above and below the normal as a percentage of the normal annual rainfall for each district. The higher the percentage the less reliable is the rainfall. Places on the same line have the same degree of variability of their annual rainfalls.

It does not follow, however, that localities situated on the 25-in. isohyet will receive 25 inches of rain every year. In many cases, this is very far from being the case. An estimate of the reliability of the rainfall of any locality can be obtained by reference to the Variability of Rainfall Map (Fig. 2). This map is redrawn from a similar map for the whole of Australia, prepared by Mr. Henry Barclay, Assistant Director of the Meteorological Bureau, who states that the "index-number presents the average departure from the normal as a percentage of the normal. The highest numbers indicate the greatest variability, and, therefore, the least reliability." It is interesting to note that the rainfall becomes less reliable as one proceeds inland from the coast, the dry north-west having the most variable rainfall. The fluctuations from year to year in the amount of rain received are much greater in the north-east than in the south-west portion of the Western District and in Gippsland.

Any consideration of total annual rainfall, even if variability also is taken into account, gives no clear indication of the intensity of conditions during the critical summer months. It is necessary to know its monthly distribution throughout the year, and also the summer temperatures.

In Table I., average monthly figures are given for a few well-known centres. The three highest monthly averages for each centre are shown in heavy type, and the three lowest in italics.

It will be seen that in practically all centres the wettest months are those of winter and spring, the summer months—December to March—being the driest. February is usually the driest month. Sale is an interesting exception, the driest months there being April, July, and August, the wettest being the late spring months. Further east in Gippsland the summer rain increases, and one or more of the summer months may even be the wettest. In comparing the different localities, the greatest differences are seen in the amount of summer rain. In any district with a reasonably reliable rainfall, and an average annual total of over 20 inches, it is unlikely that the rainfall during the winter months will be seriously below

TABLE I.

——	No. of Years Record.	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
Lismore	50	*123*	*115*	*162*	163	186	**201**	175	188	**219**	**198**	167	140	2,037
Colac	27	*123*	*126*	192	179	287	**330**	283	**307**	**290**	247	200	*171*	2,735
Bendigo	65	*123*	*121*	150	148	212	**269**	203	**221**	**220**	196	146	*118*	2,127
Mansfield	26	*161*	*129*	218	*159*	251	**305**	281	263	**289**	**285**	201	184	2,726
Wangaratta	26	*129*	*119*	175	*131*	245	**340**	**290**	**248**	236	218	171	179	2,481
Warragul	38	*272*	*166*	*291*	317	374	389	346	**401**	**423**	**432**	322	310	4,046
Sale	54	194	183	224	*171*	194	185	*164*	*170*	**235**	**241**	**223**	199	2,383

Figures in points—100 points=1 inch.

Fig. 3.—Average Rainfall for Summer Months, Mid December to Mid March. 100 points = 1 inch.

requirements, but that received during the summer period may be very much below the requirements of perennial plants. In order to enable a simple comparison between districts, a map has been prepared to show the average rainfall for the summer months—mid-December to mid-March (Fig. 3). This is the three-months' period of highest temperature and, in general, lowest rainfall.

Where the rainfall for this period is above about 7 inches, the summer cannot be termed severe, and will impose relatively little strain on any of the common perennial pasture plants. Only a comparatively small portion of the State receives this amount of summer rain, and this area includes much rough mountainous country, as well as a good deal of the most productive land in the State. Where the rainfall received is below this figure, conditions become correspondingly acute, particularly where temperatures are high and the humidity of the air low. The chief effect of high temperature and low humidity is to increase water evaporation from the soil, and transpiration from the

leaves of plants, and reduce, therefore, the effectiveness of the rainfall. Temperatures, and therefore evaporation, are highest in northern Victoria, as shown by an annual evaporation of 50.8 inches from a free water surface at Rutherglen, compared with 38.4 inches for Melbourne. Evaporation at Hobart is 32.4 inches. Thus a 4-in. summer rainfall may be more effective in southern Victoria than a 5-in. summer rainfall in northern Victoria.

It is not possible to give a definite figure as the minimum required for the survival of introduced perennial pasture plants. The various species differ in the degree of their resistance to dryness, or in their ability to assume a resting state, as will be shown when considering species. Four inches of summer rain may be taken as the minimum below which very few will survive for more than a short time, and many species will disappear before this figure is reached. On heavy soils in the Western District, perennial rye grass is often the dominant grass where the summer rainfall is little in excess of this figure. In areas between the 4-in. and 7-in. summer isohyets, the ability of perennials to "over-summer" will depend on the characteristics of the plant under consideration, the summer temperature, soil, aspect, or other influences. Conditions are more severe on exposed northerly slopes than on slopes with a more sheltered aspect—sheltered, that is, from drying winds, and to a certain extent on southern slopes from the direct rays of the sun.

If the figures for four widely separated localities, each having approximately the same average annual rainfall, are examined, considerable differences are brought out. (See Table II.)

TABLE II.

District.	Average Annual Total.	Summer Rain.	Variability.	Five Years Limits of Rainfall.*
			%	
Ballarat ..	27·16	4–5	20	22·5—32
Colac ..	27·35	4–5	17	23 —31
Stratford..	26·13	6	15	23 —29
Benalla ..	26·46	4–5	26	20·5—32

* The limits above or below which the rainfall may be expected to fluctuate in any five-year period.

An inspection of Table II. shows that, though the average annual rainfall of Ballarat, Colac, Stratford, and Benalla is approximately the same, the summer rainfall averages 1½ inches higher at Stratford than at the other three places, so that we may expect summer growth and the persistence of perennials to be influenced accordingly. The rainfall is also less variable (or more reliable) at Stratford than at the other places, especially Benalla, where fluctuations between 20.5 and 32 inches may be expected during any five-year period, as compared with 23 and 29 inches at Stratford. There is also a higher average summer temperature in the northern districts, which will have an effect on the efficiency of the rain that falls during the summer months, and a corresponding influence on growth and the persistence of perennials.

It will be apparent that both native and introduced species of pasture plants have been, and are being, subjected to intense climatic influences which result in a selection of types adapted to any area, and in the elimination of those whose inherited characteristics prevent them from conforming to the conditions imposed. The diverse characters of our native species will be suggested by an account of their distribution in relation to the climatic and other factors of their habitats, but as less is actually known of them than of introduced species, the account which follows is necessarily brief.

Native Species.

The first studies of new vegetation, such as our pioneer botanists found on arrival here, were necessarily directed towards naming and classifying the species of which it is composed. This has been largely achieved for us by such eminent botanists as Brown, Bentham, Mueller, and others. They also recorded the districts where each species was found, and later botanists have contributed extensively to these accounts. Our native vegetation has thus been well classified, and it is known where each species occurs, but so far there is little recorded in regard to the abundance or frequency of occurrence of each species in any area. It is desirable that this should be known as native species of trees, shrubs, and grasses, are often excellent indicators of the potential agricultural, pastoral, or other value of new land. Botanists to-day are devoting themselves more to studies of this important aspect, and we may expect the results of their researches to be very valuable to the State.

There are a few general facts known about the distribution of some common native grasses.

They are all widely distributed, and occur in very different places, but as a rule each shows particular adaptation to a special set of climatic and soil conditions under which it may dominate a pasture, and even form a pure stand. The extent to which any situation differs from or agrees with the ideal habitat of a species apparently determines its frequency of occurrence in that situation. Various areas are known where some of our native grasses form practically pure swards. A brief account of such areas will suggest the nature of apparently ideal habitats of a few different species, and at the same time show that each makes incursions into less favorable and usually occupied territory in its determined efforts to acquire and colonize new lands. At the same time, its equal resistence to intrusion into its own strongholds will be realized.

It will be convenient first to classify these areas mainly in relation to rainfall, noting the grasses occuring in each area, and then to give descriptions in general terms. Only a few such cases are attempted.

Area I.—*Light to moderate rainfall* (15 *to* 24 *inches annually*), *other climatic conditions fair, medium soils of extensive plains:—*

Wallaby grasses (*Danthonia* spp.) dominant; Spear grass (*Stipa* spp.) frequent or occasional.

Area II.—*Moderate to heavy rainfall* (25 *to* 40 *inches annually*), *other climatic conditions good.*

Light and medium soils.—Kangaroo grass (*Themeda trianda*), Love (*Eragrostis* spp.), Rice (*Microlaena stipoides*), and Pigeon grass (*Setaria* spp.) in combination; or Ratstail (*Sporobolus indicus*) dominant.

Medium and heavy soils.—Tussock grass (*Poa caespitosa,* and its variants) dominant.

Area III.—*Moderate to heavy rainfall, cold winters and late springs; river flats of medium texture:—*

Mat grass (*Rottboellia compressa*) dominant.

Area IV.—*Moist or swampy soils, reasonably dry in summer:—*

Small Paspalum (*Paspalum distichum*), Marsh Foxtail (*Alopecurus geniculatus*), Swamp Wallaby (*Amphibromus* spp.), and Manna grass (*Glyceria fluitans*), dominant or frequent.

Area V.—*Alpine areas:—*

Wallaby grass (*Danthonia robusta*).

Wallaby grass (Area I.) is very well known. Many different kinds have been recognized by botanists, each exhibiting adaptation to special conditions within the main habitat. It is the main native grass of our pastoral areas, and occupies chiefly the plain country of the Western and the Northern and North-Eastern Districts. It occurs also on extensive plains stretching from Rosedale to Bairnsdale, in Gippsland. It is the dominant grass of a typical sward of these areas, few other species being normally important. These districts have become famous as merino sheep country, though they are used also for cattle grazing.

Wallaby grass is common as well in the Gippsland hills (Area II.), but it meets with strong competition from bracken and other tall plants, and only under special grazing conditions does it remain dominant. In such favorable areas of the State, land cleared by ring-barking and grazing usually forms a sole of Wallaby grass in place of the shrubs and herbs that formerly held the soil. Regular grazing appears to be necessary to maintain it however, as the land reverts to bracken, shrubs, dogwood, and wattle if left neglected or inadequately grazed. In the pastoral areas referred to, there is little bracken, shrub, or other tall growth, and Wallaby grass persists and remains dominant under a variety of conditions. The introduction of subterranean and other clovers has been found to effect an outstanding improvement in the carrying capacity of Wallaby grass pastures, in at least the areas of moderate rainfall of the State, especially under a system of phosphatic top-dressing.

The Spear (Area I.) or *Corkscrew grasses* (so called because of the spiral twist to the awn of the seed) are well known, especially to pastoralists, who frequently have encountered much trouble amongst their flocks because of the injuries inflicted by the seeds of these plants. They are of low fodder value, and are definitely objectionable. There are many different spear grasses, and, in one form or another, they are widely distributed over the whole State. Some species show special adaptation to dry conditions, and are confined to the Mallee. Others enjoy a general distribution, but flourish particularly in areas of moderate rainfall in Southern Victoria. The peculiarities of this genus in respect of habitat are not so clearly defined as in the case of some

others. There is a general opinion that the spear grasses have disappeared to a large extent under regular and heavy grazing, and a pure sward is now relatively rare, and most likely to be found only in sheltered areas.

Kangaroo Grass (Area II.) is freely distributed in areas of moderate to heavy rainfall. It occurs only sparingly in the interior. It is abundant in Central Victoria (Melbourne district), and perhaps especially near Lilydale. It is common also in Gippsland, as for instance, around Traralgon. A field of Kangaroo grass has a characteristic brown colour, which makes it easily distinguishable. As a grazing plant it is less important than Wallaby grass, though it is a much larger plant. Graziers frequently note its disappearance under regular and close grazing, especially by sheep. It sets very little fertile seed, and new plants are slow to arise and replace those lost under grazing. It is seen at its best in places along the Gippsland railway lines, where it escapes grazing, and undergoes an occasional burning only. It thrives under such conditions, and covers the ground for many miles. It has shown no great promise under intensive grazing, and offers dubious prospects for general pasture purposes.

Love Grass (Area II.) occurs mainly in the coastal and North-eastern districts. It grows on moderately fertile, undulating country, and if the spring and summer rainfall is adequate, it produces a fair supply of herbage, palatable to stock. It may be plentiful or even abundant in a pasture, as in the rising country beyond Dandenong, but is usually dominant only in patches here and there in a field, and not over the whole of it. Similarly, with Rice grass, which is usually to be found in the same fields as Love grass. It prefers a loamy soil in which its short underground stems may push out from the parent plant without much resistance. It is also dominant only in patches in fields where it occurs. Pigeon grass is cosmopolitan in its habits, and usually occurs as single plants only in the areas where it has gained admittance. Though expression is heard occasionally of the potential value of Love grass as a grazing plant, it is doubtful with these three plants, as with Kangaroo grass, whether they will persist to any extent under grazing. It is certainly only in lightly-grazed fields that they occur plentifully. *Ratstail* (Area II.), so called because of the likeness of the ear to the tail of the rodent, is well known around Melbourne, through Gippsland, and on Phillip Island. It occupies light or gravelly soils, inclined to be dry in summer. It is deep-rooted, and drought-resistant, but as tough a grass as our cattle ever graze.

Tussock Grass (Area II.) is perhaps as well known as Wallaby grass. It is widely spread in all moist districts of the State, and often occurs in moist situations in moderately dry districts. It shows a preference for fairly

A native grass area—Wallaby Grass supports most of our sheep.

heavy soils on both plain and hill country. Extensive areas occur on the level plains of the Western District and along many Gippsland river flats. If it is ploughed under in these last areas, it is usually followed by the black rush (*Juncus* spp.) as a weed. It is often abundant and dominant in the hill country of Gippsland and Beech Forest, especially the Apollo Bay area. It is of doubtful value as a grazing plant, except after a burn or when it is kept short by hard grazing. Its presence may be taken as an indication of a good subsoil. On flat country in the Western District, it is usual for Strawberry Clover to do well if Tussock grass has found the same conditions congenial. Likewise, in Gippsland, though here White Clover may grow to better advantage. On flat country also, Perennial Ryegrass is likely to do well where Tussock occurs, and on the hill country Cocksfoot may be expected to effect establishment. Tussock is not specially resistant to grazing, and, in fact, after the introduction of Strawberry or White Clover, and Ryegrass into a river flat, it tends to disappear, especially under manurial treatment.

Mat Grass (Area III.) is common on river flats of tributaries to the Upper Goulburn River and in Gippsland, areas where a relatively long cold winter prevails, with a late spring and moderate summer weather. Having rhizomes or underground stems, it is an aggressive plant, and under favorable conditions may completely dominate a pasture. It is adapted to soils of medium texture in which its rhizomes may ramify freely. Its presence on a large scale generally indicates conditions suitable for paspalum.

Several native grasses are adapted to very moist or swampy conditions (Area IV.). Small Paspalum (also called Water Couch and Silt grass) occupies much of such land through Gippsland. It occurs abundantly at Orbost, and is there encouraged by the mild climate and good summer rains. The small irrigated pastures on the hills around Bendigo frequently become a pure sward of *Paspalum distichum*, and are wonderfully productive. Marsh Foxtail is abundant and productive in a few small areas, notably the Gormandale flats, near Traralgon, but more commonly it occurs only as patches in favorable spots over a field. Swamp Wallaby and Manna grass are widely distributed in moist situations, but, as a rule, are not dominant, or even important constituents of the herbage of such areas.

There is little information recorded in respect of the flora of the Bogong and the Dargo High Plains, which are our chief alpine areas (Area V.). It is known, however, that a very distinct Wallaby grass (*Danthonia robusta*) is the principal native species, and affords considerable grazing during the spring and summer months.

A review of our principal native grasses is not wholly impressive in regard to their value as pasture plants, with the exception of Wallaby grass, which probably supports the bulk of the sheep population of the State. Our knowledge in respect of them, however, is very limited, and a thorough investigation of their frequency of distribution, together with an accurate estimate of their agronomic possiibilities, has still to be undertaken.

Grateful acknowledgment is made to Mr. Henry Barclay, Assistant Director, Commonwealth Meterological Bureau, for the preparation of the maps used in this article.

(An account of the distribution of introduced pasture species will be published in a subsequent issue.)

Manurial Trials with Potatoes

Results for 1931-32 Season—No. 2

By J. T. Ramsay, Potato Expert.

[*The first portion of this report, dealing with the results of the trials at Illowa, Koroit, Millbrook, and Fish Creek, appeared in the September issue of this Journal.*]

CHILDERS-THORPDALE.

THIS series of trials is carried out on hill country in Central Gippsland, on soil typical of a large area in this portion of the State. Tests have been conducted on a clay loam soil on the farm of Mr. W. Baird, of Childers, for nine years, and because of the definite information gained from previous experiments two alterations were made last season in the manurial programme. The first of these was the dropping out of the plot manured with superphosphate at the rate of 9 cwt. per acre, previous tests having shown definitely that such heavy manuring was not required for maximum returns.

The second alteration was the elimination of a plot treated with potash in conjunction with super. This combination had been proved to be an unprofitable investment. The "6 and 1" mixture, i.e., 6 cwt. super. and 1 cwt. ammon. sulp., had given such consistently good results that it was decided to try increased quantities of nitrogenous fertilizer in conjunction with the 6 cwt. super. and two plots were added. One plot was treated with 6 cwt. super. and 1½ cwt. ammon. sulp., while the other received 6 cwt. super. and 2 cwt. ammon. sulp. per acre. Childers was one of the districts which had not sufficient rain at the right time, and yields were only moderate. Notwithstanding that fact the expenditure on the extra quantities of ammonium sulphate was justified. Of course, these results will need to be confirmed by further trials before it can be safely recommended that extra nitrogenous fertilizer should be used in this district. The highest return in the Childers trials last year was given by the dressing of 6 cwt. super. and 2 cwt. ammonium sulphate per acre, the increase being 3 tons 17 cwt. per acre over the "no manure" plot—an increase of 118 per cent. Then followed the "6 and 1½" dressing, with an increase of 3 tons 2 cwt. per acre (95 per cent.) and the "6 and 1" dressing, with an extra yield of 2 tons 12 cwt. per acre (80 per cent.). The yield from the unmanured plot was only 3 tons 5 cwt. per acre. Market garden manure and basic phosphate compared unfavorably with the same quantities of super. alone, both in the matter of yield and also because of their very high cost per ton of increased weight. The

TABLE XII.—POTATO MANURIAL TRIALS, CHILDERS, 1931-32.

Variety—Late Carman.

Manure per acre.	Weight Market Tubers.	Increase due to Manure.	Percentage Increase.	Cost per Ton Increase.
	T. C. Q.	T. C. Q.	%	£ s. d.
Super., 3 cwt...	5 7 0	2 2 0	64	0 6 9
Super., 6 cwt...	5 15 0	2 10 0	77	0 10 5
Super., 6 cwt., amm. sulp., 1 cwt. ..	5 17 0	2 12 0	80	0 15 7
Super., 6 cwt., amm. sulp., 1½ cwt. ..	6 7 0	3 2 0	95	0 15 0
No manure ..	3 5 0	..	..	..
Super., 6 cwt., amm. sulp., 2 cwt. ..	7 2 0	3 17 0	118	0 13 3
Super., 6 cwt., amm. sulp., 1 cwt., pot. sulp., 1 cwt.	5 17 0	2 12 0	80	1 2 2
Market garden, 6 cwt. ..	5 12 0	2 7 0	72	1 1 9
Basic phos., 6 cwt. ..	4 2 0	0 17 0	26	2 2 4

plot including potash again failed. Table XII. gives the results for Childers for 1931-32, while the average returns from various manures for nine years are shown in Table XIII. From this latter table will be seen the remarkable consistency of performance of the "6 and 1" dressing over that long period. The fact that averages for only three years can be given for market garden manure and basic phosphate is due to their respective rates being increased from 3 cwt. per acre to 6 cwt. per acre three years ago.

TABLE XIII.—AVERAGE RESULTS, CHILDERS, FOR NINE YEARS, 1923-24 TO 1931-32.

Manure per Acre.	Average Tonnage.	Average Percentage Increase.
	T. C. Q.	%
Super., 3 cwt.	4 12 0	100
Super., 6 cwt.	5 1 0	117
Super., 6 cwt., amm. sulp., 1 cwt.	6 0 0	160
Super., 6 cwt., amm. sulp., 1½ cwt.	6 7 0	95 (1 year only)
No manure	2 6 0	..
Super., 6 cwt., amm. sulp., 2 cwt.	7 2 0	118 (1 year only)
Super., 6 cwt., amm. sulp., 1 cwt., pot. sulp., 1 cwt. ..	5 12 0	143
Market garden, 6 cwt. ..	3 14 2	112 (3 years only)
Basic phos., 6 cwt.	2 17 0	64 (3 years only)

The results of the variety trials are shown in Table XIV. In these tests each plot was manured with 6 cwt. super. and 1 cwt. ammonium sulphate per acre.

TABLE XIV.—VARIETY TESTS.

	T. C. Q.
Up-to-date	6 17 0
Late Carman ..	7 0 0
Manistee	5 5 0
Snowflake	6 12 0
Coronation	7 2 0
Prolific	6 10 0
Ruby Red	5 17 0
American Rose ..	2 12 0

TRENTHAM EAST.

Moderate yields were harvested at Trentham in the Central District—the heaviest being 8 tons 6 cwt. per acre from the "3 and 1" mixture. This was 4 tons 19 cwt. per acre above the crop from the unmanured plot, or an increase of 147 per cent. obtained for an expenditure of 5s. 3d. per ton increase. This treatment showed the maximum profit from manure at this centre for the past season.

TABLE XV.—POTATO MANURIAL TRIALS, TRENTHAM EAST, 1931-32.

Variety—Snowflake.

Manure per Acre.	Weight Market Tubers.	Increase due to Manure.	Percentage Increase.	Cost per ton Increase.
	T. C. Q.	T. C. Q.	%	£ s. d.
Super., 2 cwt...	5 10 0	2 3 0	64	0 4 5
Super., 3 cwt...	6 12 0	3 5 0	97	0 4 4
Super., 4 cwt...	6 18 0	3 11 0	106	0 5 4
No manure ..	3 7 0	..	..	..
Super., 3 cwt., amm. sulp., 1 cwt.	8 6 0	4 19 0	147	0 5 3
Super., 3 cwt., amm. sulp., 1 cwt., pot. sulp., 1 cwt.	7 17 0	4 10 0	134	0 10 0
Market garden, 3 cwt. ..	7 9 0	4 2 0	122	0 6 2
Basic phos., 3 cwt. ..	6 10 0	3 3 0	94	0 5 8

TABLE XVI.—AVERAGE RESULTS, TRENTHAM EAST, FOR FIVE YEARS, 1927-28 TO 1931-32.

Manure per Acre.	Average Tonnage.	Average Percentage Increase.
	T. C. Q.	%
1. Super., 2 cwt.	5 3 0	71
2. Super., 3 cwt.	5 18 0	96
3. Super., 4 cwt.	5 14 0	90
4. No manure	3 0 0	..
5. Super., 3 cwt., sulp. amm., 1 cwt.	6 12 0	120
6. Super., 3 cwt., sulp. amm. and pot. sulp., 1 cwt. each	5 18 0	96
7. Market garden, 3 cwt. ..	5 1 0	68
8. Basic phos., 3 cwt. ..	4 17 0	61

The "complete manure" dressing, including super., ammonium sulphate, and sulphate of potash, produced only 7 tons 17 cwt. at an added cost of 18s. 9d. per acre. The next best in performance was the market garden manure with a yield of 7 tons 9 cwt., an increase of 4 tons 2 cwt. per acre, or 122 per cent. over the "no manure" plot which yielded 3 tons 7 cwt. per acre. It should be noted, however, that while the "3 and 1" dressing produced an increased yield of 147 per cent. at a cost per ton of 5s. 3d., the 122 per cent. increase given by the market garden

manure was obtained at an increased cost of 6s. 2d. per ton. The results of the Trentham tests, which were conducted on a volcanic loam soil on the farm of Messrs. O'Brien Brothers, are set out in Tables XV. and XVI.

WHEATSHEAF.

While the results at Wheatsheaf in the Central District are not so spectacular as are those at other centres, they show definitely profitable results from the use of fertilizers. This red volcanic soil is one which does not respond to the heavier phosphatic dressings, 3 cwt. per acre appearing to be the most from which a profitable return can be expected.

TABLE XVII.—POTATO MANURIAL TRIALS, WHEATSHEAF, 1931-32.

Variety—Snowflake.

Manure per Acre.	Weight. Market Tubers.	Increase due to Manure.	Percentage Increase.	Cost per ton Increase.
	T. C. Q.	T. C. Q.	%	£ s. d.
Super., 2 cwt...	6 8 0	1 14 0	36	0 5 7
Super. 3 cwt.,..	6 7 0	1 13 0	35	0 8 8
Super., 4 cwt...	6 7 0	1 13 0	35	0 11 6
No manure ..	4 14 0	..	..	..
Super., 3 cwt., amm. sulp., 1 cwt. ..	9 0 0	4 6 0	91	0 6 1
Super., 3 cwt., amm. sulp., 1 cwt., pot. sulp., 1 cwt.	8 0 0	3 6 0	70	0 13 7
Market garden, 3 cwt. ..	6 10 0	1 16 0	38	0 14 2
Basic phos., 3 cwt. ..	6 7 0	1 13 0	35	0 10 11

The maximum return at Wheatsheaf last season was obtained from the "3 and 1" dressing, which gave an increase of 4 tons 6 cwt. per acre (91 per cent.) over the "no manure" plot yield of 4 tons 14 cwt. per acre at a cost of 6s. 1d. per ton increase. That result was outstanding, and was not approached, even approximately, by any other rate or kind of application. The next best was the complete manure (6 cwt. super. and 1 cwt. ammon. sulp. and 1 cwt. potash), which gave an increase of 70 per cent., at a cost of 13s. 7d. per ton.

Results of the Wheatsheaf trials, which are carried out on the farm of Messrs. Jas. Gooch and Sons, are detailed in Tables XVII. and XVIII.

TABLE XVIII.—AVERAGE RESULTS, WHEATSHEAF, FOR FOUR YEARS, 1928-29 TO 1931-32.

Manure per Acre.	Average Tonnage.	Average Percentage Increase.
	T. C. Q.	%
1. Super., 2 cwt.	4 4 0	37
2. Super., 3 cwt.	4 9 0	45
3. Super., 4 cwt.	4 12 0	50
4. No manure	3 1 0	..
5. Super., 3 cwt., amm. sulp., 1 cwt.	5 12 0	83
6. Super., 3 cwt., amm. sulp. and pot. sulp., 1 cwt. ..	6 2 0	54 (3 years only)
7. Market garden, 3 cwt. ..	4 11 0	49
8. Basic phos., 3 cwt. ..	4 9 0	45

MUSK.

Musk (Central District) suffered more from adverse weather than any other district in which potato trials are carried on. For that reason yields were very light; nevertheless the manures showed to considerable advantage, and, in spite of the low yields and low prices, returned fair profits.

TABLE XIX.—POTATO MANURE TRIALS, MUSK CREEK, 1931-32.

Variety—Snowflake.

Manure per Acre.	Weight Market Tubers.	Increase due to Manure.	Percentage Increase.	Cost per ton Increase.
	T. C. Q.	T. C. Q.	%	£ s. d.
Super., 2 cwt...	3 5 0	1 14 0	109	0 5 7
Super., 3 cwt...	3 7 0	1 16 0	116	0 8 0
Super., 4 cwt...	3 18 0	2 7 0	151	0 8 1
No manure ..	1 11 0	..	..	..
Super., 3 cwt., amm. sulp., 1 cwt. ..	3 12 0	2 1 0	132	0 12 10
Super., 3 cwt., amm. sulp., 1 cwt., pot. sulp., 1 cwt.	3 19 0	2 8 0	154	0 18 9
Market garden, 3 cwt. ..	3 8 0	1 17 0	119	0 14 0
Basic phos., 3 cwt. ..	2 12 0	1 1 0	67	0 17 0

On the volcanic loam of this district an exceptional result was given, inasmuch as the complete manure, viz., super. 3 cwt., ammon. sulp. 1 cwt., and potash sulp. 1 cwt., gave the highest yield, 3 tons 19 cwt. per acre.

The next best return was that from 4 cwt. super., 3 tons 18 cwt., while the "3 and 1" dressing gave 3 tons 12 cwt. as against 1 ton 11 cwt. from the unmanured plot. This last plot suffered very severely from damage by green aphis to such an extent as to practically nullify the results of the experiment of last year. Tables XIX. and XX. show the results at Musk for last season and the average returns for four years from the various manurings. The trials at Musk are conducted on the property of Messrs. Bull Brothers.

TABLE XX.—AVERAGE RESULTS, MUSK, FOR FOUR YEARS, 1928-29 TO 1931-32.

Manure per Acre.	Average Tonnage.	Average Percentage Increase.
	T. C. Q.	%
1. Super., 2 cwt.	3 17 0	22
2. Super., 3 cwt.	4 4 0	33
3. Super., 4 cwt.	4 9 0	41
4. No manure	3 3 0	..
5. Super., 3 cwt., sulp. amm. 1 cwt.	5 4 0	64
6. Super., 3 cwt., sulp. amm., and pot. sulp., 1 cwt. each	5 5 0	43 (3 years only)
7. Market garden, 3 cwt. ..	4 8 0	39
8. Basic phos., 3 cwt. ..	4 2 0	30

ROMSEY.

The volcanic soil at Romsey (Central District) appears to be one of the least responsive to artificial manurial treatment. Experiments have been carried out there for several years without decisive results comparable to those of other districts. Certainly the season's (previous to the last) in which experiments have been conducted, have not been favorable to good yields or to the action of fertilizers, but the fact remains that definitely marked increases in yield have not followed the use of the fertilizers tried. Even last year—when the season was favorable for the late crop—the greatest difference between any manured section and the unmanured plot was only 41 per cent., the unmanured plot yielding 7 tons 2 cwt. while the "3 and 1" manure gave a return of 10 tons, an increase of 2 tons 18 cwt. per acre. This increase, of course, is a significant one, but it does not compare with the increases obtained from manures in other places.

Neither condition of seed nor class of cultivation can be put forward as explanations for this lack of response to manures by the Romsey soil, because Messrs. Spring Brothers, on whose farm these tests are conducted, are fully cognizant of the value of good seed and good cultivation. Detailed Romsey results are shown in Tables XXI. and XXII.

TABLE XXI.—POTATO MANURE TRIALS, ROMSEY, 1931-32.

Manure per Acre.	Weight. Market Tubers.	Increase due to Manure.	Percentage Increase.	Cost per ton Increase.
	T. C. Q.	T. C. Q.	%	£ s. d.
Super., 2 cwt...	9 4 0	2 2 0	29	0 4 6
Super., 3 cwt...	10 7 0	3 5 0	45	0 4 4
Super., 4 cwt...	9 5 0	2 3 0	30	0 8 10
No manure ..	7 2 0	..	..	..
Super., 3 cwt., amm. sulp., 1 cwt. ..	10 0 0	2 18 0	41	0 9 1
Super., 3 cwt., amm. sulp., 1 cwt., pot. sulp., 1 cwt.	8 14 0	1 12 0	22	1 8 1
Market garden, 3 cwt. ..	8 13 0	1 11 0	22	0 16 5
Basic phos., 3 cwt. ..	8 13 0	1 11 0	22	0 11 7

TABLE XXII.—AVERAGE RESULTS AT ROMSEY FOR FOUR YEARS, 1928-29 TO 1931-32.

Manure per Acre.	Average Tonnage.	Average Percentage Increase.
	T. C. Q.	%
1. Super., 2 cwt.	5 12 0	20
2. Super., 3 cwt.	6 7 0	37
3. Super., 4 cwt.	5 8 0	16
4. No manure	4 13 0	..
5. Super., 3 cwt., sulp. amm., 1 cwt.	6 5 0	34
6. Super., 3 cwt., sulp. amm. and pot. sulp., 1 cwt. each	6 13 0	18 (3 years only)
7. Market garden, 3 cwt. ..	5 14 0	22
8. Basic phos., 3 cwt. ..	5 13 0	21

BEECH FOREST.

Last year, for the first time, systematic manurial trials were carried out at Beech Forest, about 25 miles south of Colac, in the Western District. The rainfall there is heavy and well distributed throughout the year, while the soil is a strong clay loam eminently suited to the production of fine quality potatoes, root crops, and pastures. Owing to its altitude (approximately 2,000 feet above sea level)

[*Continued on page* 489.

Gifts for Friends Overseas

Advertising Victorian Produce

IN THE FOLLOWING supplement is reproduced portion of a booklet prepared by the Victorian Department of Agriculture, for distribution in Great Britain in connexion with the "gifts" scheme for advertising Victorian produce abroad.

This scheme was inaugurated by the Department of Agriculture four years ago in order to facilitate the forwarding overseas of presents of produce grown in this State. It was thought that many Australians with friends and relatives in Great Britain would be glad to take advantage of the opportunity to forward at Christmas, Easter, or other period of the year, a present that, while being of use to the recipient would be at the same time a valuable advertisement for the produce of Victoria's fertile soils. That this was so is indicated by the fact that the scheme has grown in popularity each year and, in 1931, no fewer than 3,506 separate gifts were ordered and delivered. Similar schemes have been put into operation recently by leading newspapers and private firms, so that, each year, a flood of presents of choicest quality Victorian produce is going into the homes of the people of Great Britain.

In the case of presents ordered through the Department of Agriculture arrangements are made to enclose with each a card conveying greetings from the donor and, in addition, a booklet containing photographs of typical phases of primary production in Victoria, and outlining a few salient facts and statistics relating to each of the principal rural industries. It is felt that the information given in this booklet, together with the high quality of the produce chosen for the gifts, will serve as an outstanding advertisement for these goods. The booklet, the inside pages of which are reproduced herewith, is printed on art paper and enclosed in a handsome cover to which is attached a three-colour reproduction of a water colour of a typical Australian pastoral scene.

Gifts of the best Victorian produce can be sent at any time through the Department of Agriculture, which makes all arrangements for delivery to the address of the recipient without any further expense than the amounts set out below. These charges cover the cost of the produce, freight, and delivery costs. Orders for gifts to residents of the Irish Free State or European countries cannot be accepted because of the heavy customs duties.

The experience of those who have taken advantage of this scheme during the last few years is that gifts of this kind from relatives and friends abroad are valued much more highly than are most other articles usually sent as gifts. In addition, such gifts establish a much closer link between the Homeland recipient and the Australian donor because of the fact that they are the products of our own country.

The gifts available and prices charged are as follow:—

	s.	d.
10 lb. of Choice Butter	17	6
30 lb. of Assorted Dried Vine Fruits	25	0
24 tins of assorted Canned Fruit ..	25	0
1 carcass of Prime Lamb ..	22	6
24 tins of Assorted Jam	25	0
24 pint bottles of Assorted Wine ..	40	0
1 case of fresh Apples (from February to May only) ..	17	6
1 case fresh Pears (from March to June only)	17	6
Mixed Case: 1-lb. Carton of Butter; 1-lb. „ Sultanas; 1-lb. „ Raisins; 1-lb. „ Currants; 1 Tin of Apricots .. ; 1 „ Peaches .. ; 1 „ Pears .. ; 3 Tins of Jam .. — for	12	6

or the above mixed assortment with the addition of—

3 Pint Bottles of Wine .. for 17 6

Orders to forward any of these to any address should be accompanied by remittances and addressed to the Director of Agriculture, Treasury Gardens, Melbourne, C.2.

Orders for Christmas delivery must be received before 31st October.

VICTORIA

VICTORIA, the garden State of Australia, comprises an area of 87,884 square miles of rich and fertile country and, though the second smallest of the six States of the Commonwealth, it produces more than one-fourth of Australia's wheat, one-sixth of Australia's wool, one-third of Australia's butter, and nearly one-third of Australia's fruit. Incidentally, it may be added that Victoria produces also one-third of Australia's manufactures.

The six and a-half million people of Australia, 98 per cent. of whom are British, purchase annually from Great Britain goods to the value of £61,603,000 —a greater amount than is bought by any other country in the world except India.

Victoria's primary industries support a large percentage of its population, including many returned soldiers and settlers from Great Britain.

Help them and help yourself by buying
Victorian Produce

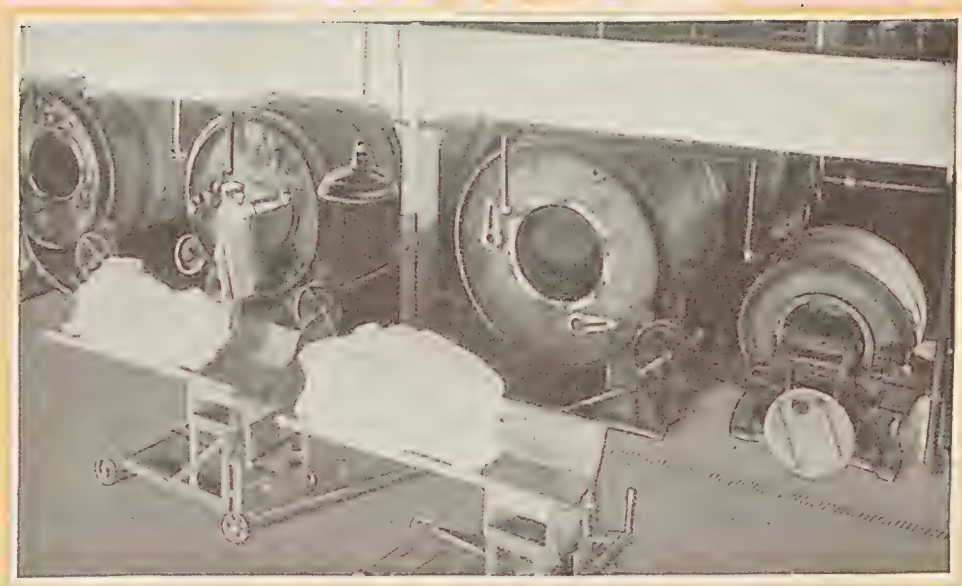
A TYPICAL HERD

VICTORIAN BUTTER

WITH its equable climate, fertile soils, and plentiful supply of water, Victoria is admirably adapted to dairying. Indeed, in few parts of the world has Nature done so much to help and so little to hinder the dairy farmer. More than 670,000 dairy cows are carried on the grasslands of the State, and the production of milk, butter, and cheese is one of its most important industries.

Victoria might well be termed the "land of sunshine dairying," since over practically the whole of the State the milking herds are able to graze out in the open all the year round. The rich grasses and clovers provide the great bulk of their feed and, unlike other countries, hand-feeding or housing of the herds is seldom necessary.

Under these favorable natural conditions Victoria's dairy herds yield abundant supplies of rich, pure milk, and in the year ended June, 1932, the production of butter in the State amounted to 57,000 tons.



BUTTER-MAKING

QUALITY SAFEGUARDED

TO ENSURE that Victorian butter shall be of the highest possible quality, strict supervision of the herds and dairy farms is maintained by the Government, which enforces stringent regulations as to the health of the cows and the workers on the dairy farm, and also as to the sanitation of the dairy buildings. The policy is to encourage and ensure the highest possible standard in the product.

Periodical inspections of the dairy farm assure the utmost cleanliness in the milking shed, in the dairy, and of the various utensils used. Factory operations are subject to similar supervision and, finally, all butter is inspected and graded by Commonwealth officers before export. Thus it can well be claimed that the production of Victorian butter is carried out under strictly hygienic conditions from the farm to the consumer.

In the year ended June, 1932, Victoria exported 35,905 tons of butter, mainly to Great Britain.

Buy Victorian Butter—
the World's Best.

DRIED FRUITS BLOCK

DRIED FRUITS

A FEATURE of primary production in Victoria is the remarkably extensive and efficient provision made for water supplies in those districts where Nature has been less generous in the matter of rainfall. Huge irrigation systems, involving the construction of storages to hold 1,350,000 acre-feet of water, have been completed already, and work now in hand will bring the total storage capacity to 2,309,000 acre-feet, or 575,000,000,000 gallons of water. More than 10,000 miles of channels have been constructed to carry this water, and in the whole of its irrigation works the State has spent £23,000,000, considerably more than half of which has been provided by investors in the United Kingdom. This water has made great areas fruitful with mile on mile of orchards, many of which are devoted to the production of dried fruits, principally sultanas, raisins, and currants. The dried fruits industry of Victoria supports a large number of growers, the great bulk of whom are Australian returned soldiers and settlers from Great Britain.

Buy Australian Dried Fruits.

GRADING AND PACKING

FOR HEALTH'S SAKE

RIPENED on the vines and in the glorious southern sunshine, Victorian dried fruits form one of the most health-giving foods available to mankind. The fruits are not picked until they are perfectly ripe ; they are dried under the direct rays of the sun, and are processed and packed with scrupulous care under strict Government supervision and under the most hygienic conditions.

The remarkably high dietetic worth and food value of currants, sultanas, and raisins have long since justified their inclusion in recipes for all courses on both plain and formal menus. Remember that when you buy 1 lb. of these dried fruits you receive actually the equivalent of 4 lb. of choice sun-ripened fruit with only the moisture removed by the process of evaporation in the warm rays of the southern sun.

Australia produces 70,000 tons of dried vine fruits annually, Victoria's share of this total being 50,000 tons. Commonwealth exports of currants, sultanas, and raisins amount to 55,000 tons, the great bulk of which goes to Great Britain.

Eat Australian Dried Fruits for your Health's Sake.

HARVESTING

CANNED FRUITS

THE AUSTRALIAN canned fruits industry is an important one, producing annually some 40,000,000 cans of apricots, peaches, and pears. Approximately 75 per cent. of this total is produced in Victoria. Large irrigation areas in Northern Victoria are devoted exclusively to the cultivation of these luscious and health-giving fruits, which are grown under ideal conditions—the sunny climate and fertile soils being particularly suitable for the growth of the highest quality products.

Only the choicest of these tree-ripened fruits are selected for processing by the large and modern canning plants, which are situated in the heart of the orchard areas, thus enabling the fruit to be canned the day it is picked.

The combination of these favorable conditions ensures the production of canned apricots, peaches, and pears, which are unsurpassed for quality and flavour.

Ask Your Grocer for Australian Canned Fruits.

HYGIENIC METHODS

EMPLOYEES in Victorian canneries work under ideal conditions, and members of the staffs take pride in the care with which the fruit is selected and graded. The latest improvements in efficient machinery and hygienic processing methods reduce the handling of the fruit to the minimum and ensure an excellent and dependable product.

Government supervision ensures highest quality

AN APPLE ORCHARD

FRESH FRUITS

ONE-THIRD of the fruit grown in Australia is produced in Victoria, within whose borders grows to perfection every kind of fruit, except those that thrive only in tropical districts. In the southern portions of the State apples, pears, and berry fruits grow well under natural rainfall conditions, but it is in the irrigation districts of the north that the fruit-growing industry has reached its highest development. There the great irrigation systems have transformed whole provinces into green oases, with comfortable homes, busy towns, and numerous canneries dotted here and there.

Although the major portion of the fruit grown in Australia is consumed within the Commonwealth, a considerable quantity is exported as dried, canned, or fresh fruit. The principal fresh fruits exported are apples and pears, and in a normal year some 1,800,000 centals of these are sent overseas. In Victoria an area of 78,000 acres is under commercial orchards, and the average production of fruits (excluding nuts and berries) amounts to some six and a-half million bushels annually.

GATHERING THE CROP

EXPORTS SUPERVISED

THE VICTORIAN Department of Agriculture maintains a staff of orchard supervisors whose task it is to make periodical inspections of the orchards, to give advice to growers, and to ensure that the trees are kept free from disease and insect pests. In addition instruction in grading and packing for export is given, the grower being shown how to place his fruit on the overseas market in the best possible condition. Regulations prescribed by the Commonwealth Government govern the grading and packing of all fruit exported, and these are rigidly enforced by inspection of the fruit just prior to shipment. At this inspection fruit is rejected if bruised, immature, overripe, diseased, slackly packed or badly graded, or if spray markings are showing. With the aid of these precautions Victoria is able to export fruit of excellent quality and equal to the best from any country.

Fresh fruit is not a luxury, but an essential food necessary for the preservation of health. There is no fruit better than that from Victoria, Australia.

A PROLIFIC VINE

VICTORIAN WINES

WINES of very high quality have long been produced in Victoria, many parts of which are admirably adapted by Nature to the production of wine grapes. Victorian wines include the leading classes produced in European wine countries, and range from light table wines, similar to Claret, Hock, &c., to the fuller-bodied Peninsula wines, such as Sherry and Port. For many years now the high quality of Australia's wines has been strikingly demonstrated by their numerous successes at Wine Shows and Exhibitions in many countries, and during the last decade there has been considerable expansion in the exports of wine from Victoria to Great Britain. In a normal year wine production in Victoria amounts to more than 2,000,000 gallons, while exports to Great Britain from this State last year totalled 302,066 gallons.

Australia has often been referred to as "John Bull's Vineyard," and, as such, is destined to supply the wine which Britain needs, but which, because of her climate, she is unable to grow herself.

AN ORCHARD SCENE

JAMS AND JELLIES

WITH its extensive orchards and huge production of fruit, Victoria manufactures annually large quantities of jams and jellies. In favorable seasons upwards of 1,000,000 cwt. of fresh fruit is used for this purpose, and more than 2,000 operatives are employed. The 36 factories manufacturing jam work under very stringent pure food laws, and their operations are closely supervised by Government inspectors.

The bulk of Victoria's jam is consumed within the Commonwealth, but an export trade is being built up, and it is hoped that, eventually, a substantial proportion of Great Britain's jam requirements will be met from this source. The quality of the product leaves nothing to be desired, and letters that have been received from satisfied consumers in all parts of the United Kingdom express high praise and appreciation of both the quality and packing of Victorian jams and jellies.

EWES AND LAMBS

LAMB AND MUTTON

LAMB-RAISING and wheat-growing form a combination popular in northern Victoria, where the large areas of natural pasture, supplemented by fodder crops and wheat stubbles, provide abundant feed for the flocks. Climatic conditions there are eminently adapted to sheep breeding and the fattening of the lambs. Approximately 6,000,000 sheep and lambs are slaughtered annually in Victoria. Local requirements absorb some 75 per cent. of this quantity, and the balance is exported, mainly to Great Britain. Modern meat freezing works have been established in the lamb-growing districts, so that the animals are treated while in their prime. The quality of these lambs has excited very favorable comment from the people of Great Britain, those who have tried Victorian lamb agreeing that they have tasted none better. All meat exported from Victoria is closely examined by competent meat inspectors, and must comply with strict regulations under the Commonwealth Commerce Act.

MERINO RAMS

WOOL

IN THE PIONEERING days Victoria was devoted very largely to pastoral industries—at first cattle-raising, and later wool-growing. Cattle-raising was gradually displaced by more intensive forms of agriculture, but sheep and wool growing continue to be an industry of major importance. Because of its soils and ideal climate Victoria enjoys a position surpassed by no other pastoral area. The wools from this State are noted for their quality, handle, and style, together with a high clean-scoured yield not always common to "super" wools.

Some parts of the State are known for their long, deep-grown wools, while others yield a wool that is short, fine, and wavy. The famous fine-wool Merinos are found mainly in the Western District of Victoria, where the dry, bracing air and pastures, consisting mainly of fine, short grasses and trefoils constitute an ideal home for fine-woolled sheep.

The annual production of wool in Victoria averages approximately 150,000,000 lb., and in a normal year the clip is worth some £10,000,000.

Wear More Wool.

AN AUTO-HARVESTER

WHEAT GROWING

WHEAT is Victoria's most important cultivated crop, the area sown annually averaging about 3,500,000 acres, while the average production over the past five years has been 40,000,000 bushels per annum. More than 90 per cent. of Victoria's wheat is produced in the northern portions of the State.

Wheat-growing methods have been brought to a high state of perfection—very thorough cultivation of the land precedes seeding, and the use of artificial fertilizers is a general practice throughout the wheat belt. Varieties particularly suitable to low rainfall areas have been developed for the more arid parts of the State, while labour-saving implements and machinery are in use by all growers. On Victorian wheat farms ploughs of many furrows, cultivators, and scarifiers of a wide spread, 16 to 22 hoe seed drills and combined harvesters and headers, capable of harvesting 15 to 20 acres of crop per day, are the standard equipment, and have helped materially to reduce the cost of production.

H. J. Green, Govt. Printer, Melbourne.

The Cherry Borer Moth

A Serious Pest to Street Trees

By R. T. M. Pescott, M.Agr.Sc., Entomologist.

Fig. 1.—An affected Oriental Plane Tree.

CURATORS of various parks and gardens for many years have advocated the planting of certain deciduous ornamental trees in the parks and streets of the municipalities with which they are concerned. The most popular of these trees appears to have been the Elm (*Ulmus campestris* Linn.) and the Oriental Plane (*Platanus orientalis* Linn.). Both of these trees, normally, are comparatively free from insect pests, and in the early days of street plantings, the trees did well. Later, both kinds, in company with the introduced Willow (*Salix Babylonica* Linn.), were attacked by the larvae of the native Cherry Borer Moth (*Maroga unipunctata* Don), a member of the family Xyloryctidae.

This particular family of moths is very well represented in Australia, while a few species are to be found also in New Zealand and South America. All members of the family possess larvae which are borers in nature. The larvae of the larger species burrow in the stems, either feeding on the bark or emerging at night time to bite through the leaf stalks, dragging the leaves to the mouths of their retreats. Those of the smaller species make galleries among spun foliage in cones of Banksia, &c.

The Cherry Borer Moth was one of the first insects figured from Australia by Donovan in 1805, whilst Edwards(1) records it as attacking the Black Wattle in 1858, as well as fruit trees in Melbourne in 1890. Olliff(2) in 1892 reports this insect as a very destructive pest of cherry trees at Blackheath (N.S.W.), whilst Froggatt(3) speaks of it as attacking shade streets at Bathurst (N.S.W.). In Victoria, French (4) records this insect as a pest of cherries, peaches, and plums, whilst French Jun. (5) in 1917 notes it as being destructive to elm and plane trees.

In its native state, the Cherry Borer lives on the Black Wattle (*Acacia decurrens* Willd.) and the Coastal Honeysuckle (*Banksia integrifolia* L. where the larvae make tunnels in the fork between two branches of the old

Figs. 2 & 3—Oriental Plane Trees at Hawthorn.

Fig. 4.—A deformed Plane Tree.

trees, and in the upright limbs of the young ones. With fruit trees the larvae tunnel for some distance under the bark, finally gnawing their way through to the heart of the tree. With shade trees such as elms and planes, the young grubs hatching from the eggs, firstly gnaw out a considerable patch of bark upon which they feed. At the same time they cover themselves with a thick meshwork of felted silk web and sawdust excrement, so that they are well protected from any external agencies.

On young trees, this surface tunnelling may continue to such an extent that the tree becomes "ringbarked," and finally dies. In some cases (see Figures 3 and 4), the tunnelling becomes so serious that, while not completely "ringing" the tree, the latter becomes very deformed and distorted, never producing a shapely, healthy street tree. After surface tunnelling for some time, the larvae then bore large holes through the sapwood into the heartwood, and when these tunnels meet, the whole area becomes damaged, and the tree eventually dies. The entrance to these tunnels also usually is covered with a web.

Life History.

The adult insect is a white satiny moth, measuring approximately 1½ inches across the outspread wings. The centre of the fore wings is characterized by a single small black spot, while the upper surface of the abdomen is black, fringed, and marked with rich orange yellow down, forming a thick tuft at the extremity. This moth emerges from the pupa in the tunnel usually only in the evening, when it may be found flying to lights. During the daytime it is rarely seen, hiding, as it does, under the loose bark of the tree.

The female moth is capable of laying up to 40 eggs on the bark of the tree, which, after several days, hatch to creamy larvae, which immediately commence to feed on the bark, as previously described. The larva or caterpillar when fully grown measures about 1½ inches in length, is of a general dull, reddish brown colour, and smooth except for a few scattered hairs along the side of the body. The head is rather large, of a rusty red colour, the under surface being pale yellow, while the legs are small and reddish brown. When fully grown these larvae turn to the pupal or chrysalid stage in the tunnels, often plugging up the top with a wad of silken web and chewed wood. After several weeks in the

(*Continued on page* 495.)

Fig. 5.—An Oriental Plane affected with Maroga unipunctata.

Potato Manurial Trials

(*Continued from page* 485).

temperatures during the growing season are mild enough to permit a steady development of the growth of the crop, a very important factor in producing high-table quality.

Of late years this district has come well to the front as a potato-producing centre, and for this reason, together with its unique situation and rainfall, it was considered advisable that departmental trials should be established there, and a site was selected on the farm of Mr. A. J. Towers.

Because of the rainfall being much heavier than that of other potato districts of high altitude, the manurial treatments were varied considerably from the usual and much heavier ratings per acre were used. These ranged from 6 cwt. super. per acre to 11 cwt. of superphosphate and ammonium sulphate in combination. Planting was done in the second week in December, 1931, and the crop was harvested on the 11th May, 1932. Throughout the season the crop gave splendid promise. The various manured plots showed up to advantage from the start—that which had not been manured being always conspicuously poorer in growth.

TABLE XXIII.—POTATO MANURE TRIALS, BEECH FOREST, 1931-32.

Variety—Late Carman.

Manure per Acre.	Weight Market Tubers.	Increase due to Manure.	Percentage Increase.	Cost per ton Increase.
	T. C. Q.	T. C. Q.	%	£ s. d.
Super., 6 cwt...	7 16 0	3 5 0	71	0 9 3
Super., 9 cwt...	8 16 0	4 5 0	93	0 10 7
Super., 6 cwt., amm. sulp., 1 cwt. ..	10 15 0	6 4 0	136	0 6 9
Super., 6 cwt., amm. sulp., 2 cwt. ..	10 18 0	6 7 0	139	0 8 6
Super., 9 cwt., amm. sulp., 1 cwt. ..	12 6 0	7 15 0	170	0 7 4
Super., 9 cwt., amm. sulp., 2 cwt. ..	12 14 0	8 3 0	179	0 8 5
Super., 6 cwt., amm. sulp., 1 cwt., pot. sulp., 1 cwt.	10 18 0	6 7 0	139	0 9 11
No manure ..	4 11 0	..	..	..
Blood and bone, 6 cwt. ..	6 16 0	2 5 0	49	1 1 4

The results obtained are highly significant. The widest difference in yield is between the no manure plot, 4 tons 11 cwt. per acre, and that dressed with 9 cwt. super. and 2 cwt. ammonium sulphate, which gave a return of 12 tons 14 cwt. per acre, or an increase of no less than 8 tons 3 cwt. per acre, equivalent to 179 per cent. This increase was produced at a cost of 8s. 5d. per ton. There was not such a great deal of difference between the "9 and 2" and the "9 and 1" (170 per cent. increase), but when the costs are analysed and the value of the crop calculated at £4 per ton (which is well below what the portion of the crop sold has realized on rail at Beech Forest), the expense of the heaviest dressing was justified on last season's figures. The lowest cost per ton of increase (6s. 9d.) was where the "6 and 1" mixture was applied, but the highest net return was obtained from the heaviest manurial treatment. This, however, is the result of only one season's trial, and further experimental work is necessary before reliable figures are obtained as to the optimum manurial dressing for this country. These results are detailed in Table XXIII.

WARRAGUL.

TABLE XXV.—POTATO MANURE TRIALS, WARRAGUL, 1931-32.

Variety—Late Carman.

Manure per acre.	Weight. Market Tubers.	Increase due to Manure.	Percentage Increase.	Cost per Ton Increase.
	T. C. Q.	T. C. Q.	%	£ s. d.
Super., 3 cwt...	10 3 0	4 13 0	84	0 3 1
Super., 6 cwt...	10 19 0	5 9 0	99	0 5 5
Super., 9 cwt...	10 16 0	5 6 0	96	0 8 1
Super., 6 cwt., pot. sulp., 1 cwt. ..	11 11 0	6 1 0	110	0 7 7
No manure ..	5 10 0	..	..	..
Super., 6 cwt., amm. sulp., 1 cwt. ..	11 7 0	5 17 0	106	0 6 8
Super., 6 cwt., amm. sulp., 1 cwt., pot. sulp., 1 cwt.	13 0 0	7 10 0	130	0 7 8
Market garden, 1 cwt. ..	11 9 0	5 19 0	108	0 8 7
Basic phos., 6 6 cwt. ..	10 2 0	4 12 0	83	0 7 10

TABLE XXVI.—AVERAGE RESULTS, WARRAGUL, FOR SIX YEARS, 1926-27 TO 1931-32.

Manure per Acre.	Average Tonnage.			Average Percentage Increase.
	T.	C.	Q.	%
Super., 6 cwt.	7	8	0	80
Super., 3 cwt.	8	8	0	103
Super., 9 cwt.	8	4	0	100
Super., 6 cwt., pot. sulp. 1 cwt.	9	9	0	127
No manure	4	3	0	..
Super., 6 cwt., sulp. amm., 1 cwt.	8	13	0	108
Super., 6 cwt., pot. sulp. and amm. sulp. 1 cwt. each ..	9	7	0	125
Market garden, 6 cwt. ..	7	1	0	70 (3 years only)
Basic phos., 6 cwt.	6	2	0	47 (3 years only)

For the first time since potato manure trials have been conducted at Warragul, the super. and potash mixture has taken second place in regard to yields being beaten by the complete manure. The difference in yield between the "no manure" plot and those manured was considerable, the greatest being between "no manure," 5 tons 10 cwt. per acre, and the complete manure, which gave an additional yield of 7 tons 10 cwt., an increase of 130 per cent. obtained at a cost of 7s. 8d. per ton of increase.

The super. and potash combination did well (110 per cent. increase at a cost of 7s. 7d. per ton), as did also the market garden manure (108 per cent. at 8s. 7d. per ton), and the super. and ammonium sulphate (106 per cent. increase at 6s. 8d. per ton).

There was practically no difference between the results of the plots treated with 6 cwt. and 9 cwt. super. per acre respectively—further proof that the effective limit of superphosphate application is reached at about 6 cwt. per acre.

TABLE XXVII.—VARIETY TRIALS.

(Manured with Super. 6 cwt. and Potassium Sulphate 1 cwt. per Acre.)

	T.	C.	Q.
Millbrook Carman ..	18	5	0
Local Carman ..	14	19	0
Late Manistee ..	11	4	0

The results obtained at Warragul are given in Tables XXV., XXVI., and XXVII. These plots are located on a clay loam on the farm of Mr. S. Adkins.

Manurial Trials, Warragul.

Produce from 1 chain rows :—(1) Complete manure, yield 94 lb.; (2) No manure, yield, 40 lb; (3) 6 cwt. super. and 1 cwt. potash, yield, 84 lb.

Young Farmers' Clubs

By A. J. Gill, Senior Herd Tester.

FOR every trade a certain amount of training is necessary, and the more extensive has been one's preparation, the more likely is one to win success. In a country where primary production is the chief source of wealth, it is certainly a matter of importance that those engaged in rural industries should be trained for their work. Our exports must compete with the primary produce of other parts of the world, and if we are to be successful we must be able to offer an article at least as good and as cheap as those of other countries.

If crops are to be grown economically, and if the production of wool and butter is to remain one of our chief sources of national wealth, it is imperative that our farmers must be scientifically trained. It has been said that if one wishes to do anything for a man, one must do it before he is a man, and thus any training for an occupation must commence early. Every child cannot attend an agricultural college, but all can be reached through the medium of young farmers' clubs. The importance of this great work is recognized all over the world. The boys and girls of to-day are the men and women of to-morrow; therefore, on their training and guiding will depend the welfare of the country. If they are to be successful, we must give them every opportunity to prepare for their future tasks. If every boy likely to remain in a rural district were given an adequate training, in a few years a large percentage of land-holders would be skilful farmers.

The wonderful opportunities there are for club work are surprising. At first glance, one will probably fail to grasp the full possibilities of the movement, and it is necessary to meet and talk with the children to know what has been done. A visitor to some of the Ballarat centres immediately becomes a club enthusiast. There are 30 clubs in that district under the one committee; the largest club having a membership of 50. Two shows are held annually; the Stock Show in conjunction with the Agricultural Society's Show in November, and the Home Projects Show held in April. Both draw large attendances. To further the movement, the parents and residents have formed a Young Farmers' Auxiliary Club. The parents' enthusiasm is expressed in the words of one of the club members when he said, "I'm going to see that my children get a better start than I did," and that is the feeling we wish to see in all country districts. Through Gippsland and, in fact, throughout the whole of the State, the movement is spreading. It is only a few months since a club was formed at Newstead by Mr. Ellis, the local school-master. Members of the club now own a total of twenty head of pure-bred stock, besides a number of fowls and pigs. Their first annual show, to be held during the present month, is not only a club show but one including a section for outsiders and adult stock-owners. At Geelong there is the striking success of a Senior Young Farmers' Club, composed of young men from 16 to 30. I had the pleasure of meeting 60 of them at Batesford at a stock demonstration on Mr. Muhlebach's farm a few weeks ago, and their keenness and determination to learn was very impressive.

Field days, lectures, and demonstrations all help to give the children an education and make them acquainted with various side lines that are such a valuable adjunct on every farm. The procuring of pure-bred animals has had a beneficial effect, which is already making itself felt. Many farmers, seeing the superiority of the pure-bred calf, pig, or fowl, are getting rid of the mongrels.

The proprietors of the *Argus* and *Australasian* are offering a shield for competition throughout Victoria, and this is expected to give a great impetus to the work of the Young Farmers' Clubs. The Chief Veterinary Officer, in conjunction with an officer from the Education Department, will act as judges.

It is hoped also that before long the movement may be extended to enable town boys to enter into partnership with country school boys in the purchase of stock. The city lad would be enabled to spend his holidays in the country and learn a good deal about the care of stock and farm work, and at the same time the nucleus of a herd or flock would be forming for both boys. This would be known as the Club Brother Movement, and every partnership would be under an agreement signed by both parties, or by parents or guardians on their behalf.

How to Form a Club.

When it is desired to form a club in any district, the teacher of the local school, or whoever is mainly interested, should call a meeting of the parents and members of the local agricultural society, and, if possible, the district school inspector; leading business people might also be specially invited.

The aims and objects of the club should be fully explained. These meetings usually have an inspiring effect, and seldom fail to arouse the enthusiasm of the people. The names of all children over eight, and to what age may be thought fit, who wish to and could carry out projects, would be obtained. This work is usually assigned to the head teacher of the local school, who almost invariably acts as secretary. A committee of residents would be formed to assist in carrying out the work and the different projects and the obtaining of the necessary pure-bred stock.

The school teacher or some active enthusiastic resident should be appointed club leader. Usually, on account of his influence with the children, the head teacher makes the most suitable club leader. He is able to closely supervise the record books, and can correlate the ordinary subjects of the school curriculum with the work. It helps to prevent the school work from becoming too artificial, and a strong link is forged between home and school life. The teacher plans and adapts his work to the special requirements of the children of the district. School work takes on a new aspect. It has a new interest. The child becomes eager to work out sums of profit and loss, and to read, study, and learn for himself. He usually shows an improvement in all school work, and many apparently indifferent children develop into eager students.

Club meetings for girls and boys are very useful. A president and secretary are chosen, the latter remaining in office perhaps for some years, but a different boy or girl would be voted to the chair at each meeting. These school meetings form a valuable part of the children's education on account of the discussions and debates on different subjects. They are taught to speak frankly and coolly and to listen to and ponder over different ideas advanced by their comrades. This must help to produce a class of farmer who will be capable, broad-minded, tolerant of others' views, always ready to instruct and learn, and a man who is capable of thinking and expressing his views intelligently. These meetings are held on strictly formal lines; they give a sense of social responsibility, and afford additional training in team work and co-operation, which mean so much in after life.

Great importance is attached to the compilation of record books. Where young farmers' competitions are held, the schedule should set out the matters that must be noted in each record book and points awarded for the completeness and accuracy of the work. Many members, in addition to their record books, are building up other books containing cuttings, illustrations from magazines and extracts from lectures, and tabulating much valuable information. Some of these books have reached a very high standard. A few clubs have established club libraries, which are of great assistance.

Method of Teaching.

The teacher may adopt a course of lectures dealing with various subjects, such as—Growing and cultivation of crops, &c.; care of cattle, judging, &c.; pastures and their improvement; care and management of poultry,

sheep, pigs, and horses; planting of trees and laying out of flower gardens; and on any subject that may be of value to the particular district in which the club is operating.

Home projects for girls might include cooking, fruit preserving, jam making and sewing; while, for boys, a suitable home project is the care of a vegetable garden.

Expert lecturers should be obtained whenever possible, and demonstrations as well as lectures should be given. Visits to farms and orchards might be arranged, where the methods followed could be explained and discussed.

Objectives and Rules.

A summary of the objects of the clubs and a set of simple rules are given below:—

The object of the clubs is to interest children in the life on the land and to help to equip them to overcome the obstacles they will meet when they commence their work as farmers. Briefly, the advantages are—

1. The work of the school and the home is closely linked because of the practical nature of the club work.
2. Scholars become interested in all branches of farm work and animal husbandry, and, being interested, do not consider the work a drudgery.
3. The stock and poultry are improved by the introduction of pure-bred stock.
4. Better farming methods are introduced and experiments carried out.
5. The child is enabled to test his ability and display any aptitude he may have.
6. The giving of an animal to a child to care for creates an interest and a pride of possession, and, by throwing a responsibility on him, develops pride in his work and a spirit of reliance.
7. Children are taught to keep a complete and accurate record of their work and results, and so a knowledge of bookkeeping is gained.
8. Club work and school work are correlated.
9. A spirit of healthy rivalry and a desire to excel is created. Members are taught to become competent judges of pure-bred stock.
10. Children are given practice in the conducting of meetings, and thus trained to express their opinion in public.
11. Team work is taught, and a spirit of co-operation fostered, which should assist the co-operative movement later in life.
12. A system of education at once practical and scientific is developed, and school work is invested with a reality hitherto absent.
13. A spirit of inquiry is fostered, and members are encouraged to gain a sound knowledge of their work, to carry out independent experiments, and to study a question from different angles, which means a broadening of the vision and renders them better able to meet and deal with difficulties they may be called on to face later in life.
14. The movement caters for the child who, though a logical thinker, may become discouraged and disinterested because of competition with scholars who are naturally better equipped for an academic course of study.
15. A spirit of honesty, industry, and truthfulness is fostered, as well as loyality to each other and to their country.

Following is a set of simple rules suggested for the management of Young Farmers' Clubs:—

1. A Young Farmers' Club shall be formed, and called the Farmers' Club.
2. A committee of seven members to be appointed; head teacher to be chairman. (Number may be altered to suit views of meeting.)
3. Meetings shall be held once monthly or twice monthly.
4. The business of the committee shall be to arrange for purchases and delivery of stock, lectures, field days, and conveyance of pupils; also to arrange for the annual show or picnic, and any general club business that might arise.
5. A district club guide or guides shall be appointed to visit and assist the children with advice, and to see that animals are being taken care of by the children. The guide or guides shall report to the chairman as to progress of stock, and shall visit the place, say, twice monthly, or when directed by the chairman.
6. The ages of club members shall be from 8 to 16. (However, the teacher may use his own discretion as to children of younger age being admitted.)
7. All children must obey the officers of the club, and take reasonable care of their stock, and keep a careful account of expenditure and profit.
8. Children must exhibit their stock at the annual show or picnic.
9. Efforts to be made to obtain trophies for competition by the different clubs and club members.
10. Stock of various kinds may be kept as the children fancy—Poultry, bee farming; home products, to include growing of vegetables, flowers, or cooking. Sewing by the girls may be taken up, and prizes offered for these at the annual show.
11. Fruit growing—Child to carry out all work, such as pruning, cultivating, spraying, &c., and to keep an account of cost and profit. Area not to be less than a quarter of an acre. The growing of any other crops may be taken up.
12. The members shall hold club meetings. A secretary shall be appointed permanently, but a different child shall take the chair at each meeting. Discussions or debates shall be carried out under the direction of the teacher, who shall determine the frequency of these meetings.
13. At the annual show, 50 points shall be the maximum for exhibit, and 50 points maximum for excellence in the keeping of records.

PARENT OR GUARDIAN'S PLEDGE.

I promise to allow to become a member of the Y. F. Club and take up as a project, and that all money earned by $\frac{\text{him}}{\text{her}}$ from this work shall be banked in $\frac{\text{his}}{\text{her}}$ name in the local Savings Bank. That I shall not interfere with $\frac{\text{him}}{\text{her}}$ unduly, and shall not sell $\frac{\text{his}}{\text{her}}$ stock or produce without $\frac{\text{his}}{\text{her}}$ and the club leader's consent.

(Signed)

Date—

Orchard and Garden Notes

By Edward E. Pescott, F.L.S.

The Flower Garden.

THE present is a busy time in the flower garden, for preparations must be made for the brilliant display of flowers required in summer and autumn. Before transplanting summer annuals, the plots should be dug over to full spade depth, at the same time turning in some animal manure or good leaf mould. In planting seedlings of annuals, unless they are strong growing types like the tall African marigolds, the plants should be set out at a distance of about 6 inches. This results in a closely planted bed with no unsightly spaces or gaps between the plants.

Phlox Drummondi seed may be sown right up to the end of November. If the seed be sown in the open garden bed, some covering protection should be given to it, otherwise the young germinating seedlings will die out in patches, especially where the soil surface is likely to become dry.

It is not necessary to sow the seed, or set out plants of the tall flowering African marigold till quite late in the season. Seedlings may be transplanted even at the end of the year. If this annual be planted in a sheltered position, where it can receive a little sun, and yet be quite protected from frosts, it will flower all through the winter and into spring. A couple of plants were noted this year in full flower at the end of September.

Among the pot plants, all ferns should now be freely watered; the soil should not be allowed to dry out, as new fronds are appearing freely. A weekly watering with weak liquid manure will give very much larger and finer fronds. Palms, Aspidistra, and other foliage plants should be sponged with weak nicotine sulphate to kill all scale and mealy bug insects.

Phlox Drummondi.

The Vegetable Garden.

Sowings and plantings of tomatoes should be made now, the seed sowings to give plants for the later crops. Tomato plants do not grow freely in the cold weather. Reports show that in the Echuca district the crops did not begin to move until the warm weather set in. When they do start to move, the plants may be manured freely to force a good strong growth. Staking is not necessary; the plants may be allowed to grow freely in a natural position.

Lettuce and radish seeds should be sown, the former in rows 9 inches apart, and the latter broadcast in the bed. As soon as germination occurs, the plants should be forced on to quick growth with both food and water. The same advice applies to cucumbers, melons, and similar plants.

In the Orchard.

Spraying for various pests is now occupying the attention of the orchardist. Many requests are coming in for a formula for a home-made lime-sulphur spray. One of the best yet found is made by boiling 100 lb. of ground sulphur and 50 lb. lime in water for an hour. The boiling must be continued for a full hour, and until the mixture is of a clear greenish amber colour. There should be 50 gallons when the boiling is completed. That is, 50 gallons of water may be used at the start, and continually added to as the liquid boils away; or, say, 60

gallons may be commenced with, boiling it away to 50 gallons. This is a stock solution, and is used at the rate of 1 in 25 with water.

There are indications that up to the time of writing, thrips are not very abundant in the orchard districts. There have been a few all through the winter, in the trees, and among flowering shrubs; but, so far, no great increase has occurred. As apples and pears are now blossoming, it is to be hoped that there will be no interference with the setting. The absence of thrips in abundance up to the present, especially in the south, probably is due to the cold or mild weather experienced, with frequent rain showers.

The Cherry Borer Moth

(*Continued from page* 488).

pupal stage, the moths emerge and commence the life cycle once more.

Control.

Trees severely attacked (as in illustrations) will, in many cases, respond but slightly to treatment, and should be removed and destroyed by fire. Trees in which individual limbs only are infected should have these limbs removed and destroyed by fire. When infection first occurs, the larvae can be killed in the tunnels by clearing away the webs from the entrances and squirting in a few drops of kerosene or carbon bisulphide, afterwards plugging the hole with clay or grafting wax.

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A view of Auburn Grove, Hawthorn, showing Oriental Plane trees that were severely attacked by larvae of the Cherry Borer Moth.

Professional Papers

[This section is devoted to professional papers and articles of a scientific character.]

Influence of a Wheat Crop on Accumulation of Soil Nitrate

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IT has been observed under widely different conditions in many countries that the growth of most crops interferes with accumulation of nitrate in the soil, cropped soil containing less nitrate than adjoining fallow land, even when allowance is made for the amount absorbed by the crop (1). That this effect prevails under Australian conditions is shown by the work (2) of Prescott and Piper, in South Australia; and by one of the writers (3) for Victorian soils. During the crop season of 1930, chemical and microbiological work was carried out on soils of the Rutherglen Experiment Farm, Victoria, in an attempt to elucidate this problem.

Environmental Conditions at Rutherglen.

The genetic character of Rutherglen soil appears to conform to that of a brown earth. In physical nature the soil profile at the plot location changes with depth from a fine sandy loam with gravel at the surface to a gravelly clay below 30 inches. Rutherglen soil has a low content of total and citric-soluble phosphoric acid, and of lime and organic matter. It is well supplied with citric-soluble potash. Total nitrogen values for various depths, from which organic matter may be judged, are set out in Table I., together with reaction values.

Rainfall at the plots during the 1930 season, and average air and soil temperatures during the period of microbiological investigation are given in Table V. Rainfall in the period preceding seed-time 1930 had been 0.34 inches in March, 1.41 inches distributed over four falls in April, and 1.92 inches in five falls during the first half of May.

TABLE I.—NITROGEN CONTENTS AND REACTION VALUES FOR RUTHERGLEN SOIL PROFILE.

Depth.	Total Nitrogen (Percentage of Air-dry Soil).	Reaction. (pH).
Inches.		
0–3	0·094	7·9
3–6	0·080	7·6
6–12	0·049	7·5
12–18	0·038	6·5
18–24	0·034	6·5
24–36	0·028	6·6

Plot Treatments.

Several plots in an area fallowed from oat stubble in April, 1929, were investigated at intervals extending till April, 1930, in order to gauge the capacity of the soil of each plot for accumulating nitrate nitrogen. Two of these plots agreed very closely in nitrate content at all stages during the fallow period, as shown by Table II. It was decided therefore to use these two plots for the present work, that designated "A" to be sown to wheat, while "B" remained fallow. "A" and "B" were immediately adjacent to each other, being separated by a pathway 3 links wide, on land specially selected for uniformity. "A" was 3 chains long and 16 links wide, area 1-34th

acre, while "B" was of the same width, but half the length of "A." The evidence recorded in Table II. having shown the plots to be closely comparable under fallow conditions, it was considered that differences in nitrate-accumulating capacity shown by these plots during the crop season of 1930 could be attributed to the effect of growth of crop on "A."

TABLE II.—NITRATE NITROGEN IN SOILS OF PLOTS "A" AND "B" DURING FALLOW PERIOD 1929-1930.

(Figures represent parts per million of dry soil to a depth of 1 foot).

—	17.5.29.	25.7.29.	28.9.29.	29.11.29.	14.4.30.
Plot "A" ..	8·2	10·5	13·7	20·2	36·7
Plot "B" ..	7·6	10·9	13·8	18·0	36·8

"A" was sown on 15th May, 1930, with wheat and superphosphate, while "B" remained fallow. During the season "B" was not cultivated, but its surface was kept clear of all vegetation by handwork. This was done in order to eliminate from the comparison any favorable effect on nitrate development which might accrue to the bare plot, if its surface were stirred as in an ordinary worked fallow.

Soil Conditions during Early Life of Crop.

The nitrate history of the cropped soil was followed by regular sampling from sowing to harvest. Plot "B," which had been found virtually identical with "A" in nitrate content in April, 1930, was not sampled again at seed-time, its nitrate level at that time being assumed to be equal to that of "A" in the tabulated data.

The early samplings of plot "A" disclose an effect which is of considerable importance under Rutherglen conditions. The nitrate values listed in Table V. show a considerable diminution in the 6-12-in. section between sowing and 13th June, the effect being carried still further by 4th July. Rainfall distribution in these intervals was such that the effect could not be attributed to leaching below 12 inches. This was confirmed by sampling to 18 inches on 4th July, showing that the nitrate content of the 12-18-in. section had not increased appreciably since seedtime.

It was concluded that there had been a notable disappearance of nitrate *within* the 6-12-in. zone. It is remarkable that such an effect should occur in this soil so low in organic matter in view of the accepted belief that large amounts of readily available organic matter are necessary in the bacterial utilization of nitrate. It would appear from this and other work at Rutherglen, and from the literature (2) that a high moisture level is the chief factor in the incidence of this effect. Although insufficient to cause deep leaching, rainfall during the intervals under consideration, following on the good rains of early May, sufficed to keep the 6-12-in. section at its field moisture capacity for the majority of the period. This effect of nitrate disappearance in subsoil undoubtedly played a large part in the nitrate history of these plots, particularly of "B" in the later months.

On the 4th July, the crop on plot "A" was in the rosette stage with about seven leaves per plant, and about ten plants per foot. After this date tillering progressed vigorously, and it appeared that, by the 21st July, the crop was entering its period of most active growth. As this was the period of greatest interest to the present work, it was decided to institute weekly samplings of both plots for a series of nine weeks.

Methods.

Soil samples were composited from ten holes systematically scattered over each plot. Soil sections 0-6 in. and 6-12 in. were represented in each case. On arrival at the laboratory, subsamples were taken for chemical and bacteriological study.

Determinations of moisture by ordinary methods and of nitrate nitrogen by the phenol-disulphonic acid method as modified by Harper (5) were carried out. Nitrite was tested for with the Gries-Ilosvay reagent and ammoniacal nitrogen determined by the method of McLean and Robinson (6).

Analyses of the crop for total nitrogen were made at intervals of roughly three weeks, using composite samples from twenty 1-foot lengths of row.

In bacteriological work, after sieving through a 1-m.m. mesh sterile screen, general

counts of heterotrophic organisms and actinomyces, and studies of Azotobacter and Clostridium, and of nitrifying organisms, were made. The dilution method was used for general counts. Plates were poured in triplicate from each final dilution, and incubated at 30° C. for 72 hours, using the asparaginate agar medium described by Thornton (7). These counts included heterotrophic organisms and actinomyces in a total count.

Non-symbiotic nitrogen-fixing organisms, i.e., Azotobacter and Clostridium, were studied along the lines suggested by Winogradsky (8). Silica-gels were used to determine the *density* of Azotobacter and soil plaques to test their *activity*. It was found very difficult to make definite counts of the Azotobacter colonies on the incubated plaques. It was decided, therefore, to classify the plaques obtained into four main types. Type 1 showed a maximum number of colonies, while type 4 was practically devoid of them. Plaques showing the appropriate intermediate characters were set in types 2 and 3. Sub-types were added by using a qualifying + or — sign. When only few Azotobacter colonies appeared (types 3 and 4), "special" plaques were prepared, some with the addition of 3 per cent. of calcium carbonate, others using a 0.1 per cent. solution of dipotassium phosphate. Silica-gel plates for determination of density of Azotobacter (not the actual number of organisms active, but their general distribution), were prepared by a combination of the methods of Winogradsky (9) and the Pasteur Institute (10). Enrichment culture tests in liquid media were used to detect the presence of nitrifying organisms. For the Nitrosomonas group, the medium of Waksman and Fred (11) was used, while that of Fred and Davenport (12) was used for the Nitrobacter group.

Results of Microbiological Examination.

1. *Heterotrophic Bacteria and Actinomyces.*

Figure 1 sets out the variations shown in the numbers of these organisms during the series of counts.

The results show a definite superiority in general microbial activity on the part of the cropped plot as compared with the bare plot, especially in the later counts. Both plots show considerable reduction in bacterial numbers in the sub-surface zone as compared with the surface 6 inches—cf. Waksman (4), p. 34. The soil sections having the higher average counts exhibit the more striking fluctuations. Variations in the sub-surface zones of both plots tend to follow those in the surface soil.

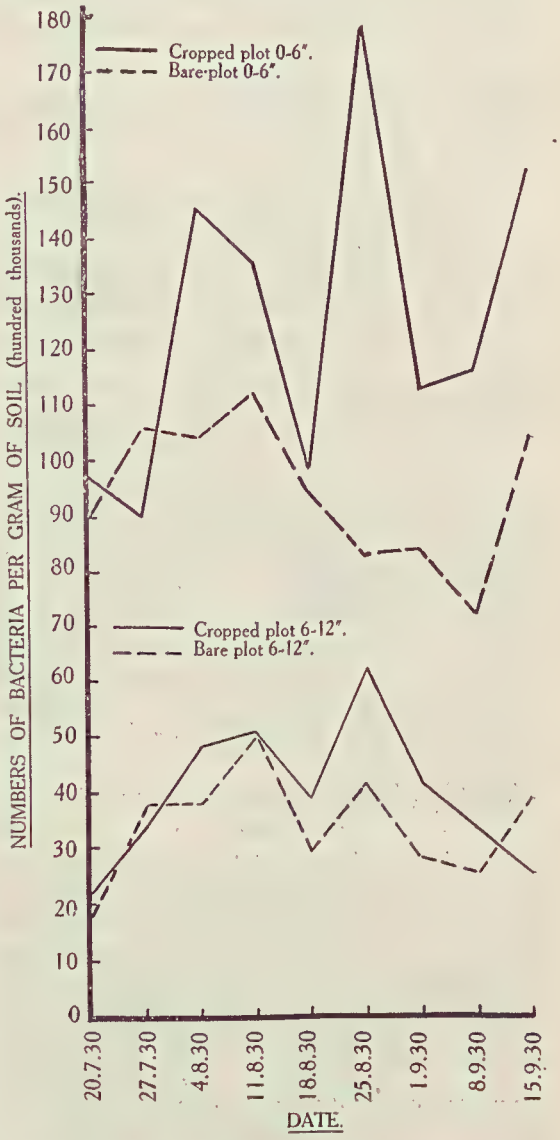

Fig. 1.—Showing total numbers of bacteria in cropped and bare soil at various times.

2. *Density of Azotobacter.*

Results for three sets of counts are given in Table III. The figures represent the numbers of definite colonies obtained by the use of 0.1 gm. of prepared soil.

TABLE III.

Silica-gel tests for density of Azotobacter.

	28.7.30.	4.8.30.	3.9.30.
Plot "A" (Cropped)—			
0–6 inches ..	8	15	16
6–12 inches ..	8	6	8
Plot "B" (Bare)—			
0–6 inches ..	Nil	14	12
6–12 inches ..	12	5	12

As far as can be judged from tests of this character, the general distribution of nitrogen-fixers was similar in the two plots. Soil conditions at any given time for each plot would determine the proportions of these organisms in an active condition. This *activity* was studied by means of plaques.

3. *Activity of Azotobacter.*

It became evident that ordinary plaque tests were of little value for comparative purposes because of extensive development of mycelium. Such plaques usually conformed to type 4 development, the indications being that Azotobacter activity was greater in bare than in cropped soil. Better opportunity for comparison was obtained in special plaques, the addition of calcium carbonate inhibiting growth of mycelium and stimulating growth of Azotobacter for both plots. Addition of phosphate had little effect on plaques from cropped soil, but a decided stimulating effect on Azotobacter development in the case of bare soil.

The best development of Azotobacter in these tests was given by bare soil when calcium carbonate and dipotassium phosphate were used together in plaques. Type 1 colonies obtained under these conditions were comparable with those obtained from a fallow soil at Rutherglen in summer, when Azotobacter was found extremely active. Such development was in marked contrast to type 3 plaques obtained from cropped soil under the same conditions. Results typical of those found throughout the series of tests are given in Table IV.

It was concluded that Azotobacter in the bare plot was on a higher plane of activity than in the cropped soil, since notable differences in favour of plot "B" were obtained from plaques prepared in the same way.

4. *Additional Plaque Tests.*

Tests with gypsum replacing calcium carbonate in the plaques supported the conclusion that available lime, rather than change in reaction, was the factor responsible for the stimulation of Azotobacter development attending the use of lime in the plaques. This is in accord with the soil reaction, which, as shown in Table I., is already favorable for Azotobacter development.

Tests with potassium sulphate instead of dipotassium phosphate showed that potassium had no specific stimulating effect on Azotobacter development. The effect of dipotassium phosphate was therefore attributed entirely to its phosphate content. These results are in accord with those given by permanent fertilizer trials with cereals at the State Farm, Rutherglen (14). Superphosphate gives notable response, lime a significant response, while potash has an insignificant effect.

TABLE IV.—TYPICAL PLAQUE TESTS ON SOILS OF PLOTS "A" (CROPPED) AND "B" (BARE).

Date.	Plaque Preparation.	Soil Section.	Plot "A" Plaque Type.	Plot "B" Plaque Type.
4.8.30	Calcium carbonate	Inches. 0–6	3	2+
		6–12	2	2
11.8.30	Dipotassium phosphate	0–6	3+	1—
		6–12	3—	1
15.9.30	Calcium carbonate and dipotassium phosphate	0–6	3	1
		6–12	3	1

5. *Isolation of Azotobacter.*

The morphology of the organism isolated from silica-gels was similar to that of a typical Azotobacter as described by Beijerinck (13).

6. *Nitrifying Organisms.*

A. *Nitrosomonas Group.* Dilutions of 1 in 100 gave positive nitrite reactions after inoculation into the ammonium sulphate medium and incubation for about seven days. The predominating organism in these cultures was a large non-motile coccus. It was not isolated in pure culture, but probably corresponds to the Nitrosococcus isolated by Winogradsky.

B. *Nitrobacter Group.* — The nitrite medium, after inoculation with soil dilutions

of 1 in 1000, and incubation for two weeks or more, gave positive nitrate reactions.

In both types of culture, the amounts of soil dilutions which gave positive results were similar from both plots, and for both depths of each soil. It was concluded that Rutherglen soil has a normal nitrifying flora—cf. Waksman, loc. cit., pp. 38, 77.

Results of Chemical Work.

1. *Nitrate Nitrogen.*

Table V. sets out the nitrate-nitrogen history of plots "A" and "B" during the 1930 crop season, together with related data. After 15th September, 1930, plot "A" only was sampled at intervals of about three weeks. After harvest the work was concluded with an investigation of the nitrate profiles for both plots to a depth of 3 feet. On 25th August, 1930, and 1st September, 1930, deeper sampling than usual was carried out to follow nitrate distribution in the lower soil zones after heavy rain in mid-August.

Table V. shows that at the beginning of September the cropped soil reached a turning point in its nitrate history. After a period of active nitrate absorption by the crop (4th August, 1930, to 1st September, 1930) a tendency to accumulate nitrate again became manifest. This is shown by slight increases in the surface 6 inches of "A" during the periods of 8th September to 29th September, 20th October to 4th December, 29th December, 1930, to 8th January, 1931. Setbacks at the ends of each of these periods were due to leaching.

The chief point brought out by the nitrate values for "A" is the relatively very poor capacity for accumulating nitrate after passing the turning point. After mid-September, practically no further nitrogen was taken up by the crop (see Table VI.), so that this was not a material factor in the low nitrate-accumulating capacity. As shown by the nitrate figures for 15th September, 1930, and 8th January, 1931, plot "B" exhibited the excellent capacity for nitrate development characteristic of bare Rutherglen soil, nor-

TABLE V.—NITRATE NITROGEN PROFILES FOR PLOTS "A" AND "B" DURING 1930 CROP SEASON (PARTS PER MILLION OF DRY SOIL).

—	—	15.5.30	13.6.30	4.7.30	21.7.30	23.7.30	4.8.30	11.8.30	18.8.30	25.8.30	1.9.30	8.9.30	15.9.30	29.9.30	20.10.30	10.11.30	4.12.30	29.12.30	8.1.31
	Inch.																		
Plot "A" (under crop)	0–6	12·1	15·6	28·0	10·2	10·0	5·6	3·1	2·2	2·0	1·7	1·0	2·1	2·9	1·7	1·8	3·1	1·1	2.1
	6–12	45·2	28·3	21·8	19·4	12·9	20·6	8·7	7·7	4·1	2·3	3·0	3·5	2·0	1·2	1·8	2·4	2·2	2·9
	12–18	11·9	..	12·4	..	..	..	..	..	5·1	5·0	..	..	..	..	..	..	..	3·4
	18–24	7·5	..	..	..	..	..	..	..	6·8	..	..	..	..	..	..	..	..	4·0
	24–30	4·7	..	..	..	..	..	..	..	5·5	..	..	..	..	..	..	..	..	3·2
	30–36																		2·8
Plot "B" (bare plot)	0–6	(12·1)	..	..	21·3	15·4	12·3	6·6	6·5	6·1	6·8	5·1	16·8	..	..	..	..	..	53·1
	6–12	(45·2)	..	..	23·8	19·4	30·3	40·4	17·6	19·6	19·2	11·9	28·6	..	..	..	..	..	9·8
	12–18	(11·9)	..	..	..	..	..	..	..	..	27·2	..	..	..	..	..	..	..	9·8
	18–24	(7·5)	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	8·5
	24–30	(4·7)	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	5·7
	30–36																		3·6

SOIL MOISTURE VALUES FOR PLOTS "A" AND "B" (PERCENTAGE OF DRY SOIL).

Plot "A" ..6	0–6	..	..	..	12·5	13·4	16·3	9·4	15·9	15·2	12·2	8·3	8·4	..	..	..	..	..	..
	6–12	..	..	..	10·8	10·1	14·8	12·3	14·1	13·4	11·7	8·6	6·7	..	..	..	..	..	..
Plot "B" ..	0–6	..	..	..	10·5	13·3	14·5	12·5	12·8	14·6	10·9	7·6	8·4	..	..	..	..	..	..
	6–12	..	..	..	9·4	9·2	12·8	10·9	14·0	12·3	11·4	9·7	9·7	..	..	..	..	..	..

RAINFALL DURING INTERVALS BETWEEN SAMPLINGS (HUNDREDTHS OF AN INCH).

Number of falls ..	4	2	3	1	2	1	2	1	1	1	3	2	5	6	3	8	1	
Total for interval ..	79	17	42	13	56	89	187	10	1	4	43	35	207	122	235	726	19	

AVERAGE AIR AND SOIL TEMPERATURES DURING INTERVALS BETWEEN SAMPLINGS (DEG. F.).

Air temp. (shade)	44	45	45	44	48	51	49	51
Soil temp. at depth of 6 inches	45	46	44	44	46	51	49	52

Crop on Plot "A" sown 15.5.30, harvested 24.12.30.

mally leading to high concentrations of nitrate in summer.

2. *Soil Moisture.*

Table V. shows only slight differences in soil moisture between the two plots. Notable differences were not expected, as these values were obtained before transpiration by the crop became most active. The field moisture capacity of the surface soil at these plots is about 14 per cent. The effect of incidence of rainfall on soil approximating to this moisture value is seen in the washing down of nitrate which occurred in plot "B" in the interval 28th July, 1930, to 18th August, 1930 (Table V). The wilting coefficient of this soil is only about 4 per cent., so that at all times during the present work there was adequate soil moisture for crop growth and bacterial activity.

3. *Nitrogen as Ammonia and Nitrite.*

Nitrite was of no practical importance in this study, never rising above a fraction of a part per million of soil. Ammoniacal nitrogen was of the order of 10 parts per million of dry soil in surface soils of both plots, and slightly less for the 6-12-in. zones. Ammoniacal values were rather higher in mid-winter than in early spring. Variations in ammonia values appeared to be quite independent of crop growth in the case of plot "A," and the values for both plots were very similar throughout.

No consistent evidence was obtained that reduction of nitrate to nitrate or ammonia was involved in the disappearance of nitrate within subsoils previously mentioned.

Final Comparison between Plots "A" and "B".

Table VI. shows as lb. per acre the nitrate nitrogen values for the soils and the nitrogen content of the crop on plot "A" during the season. On 8th January, 1931, the soil of the bare plot stood to advantage over that of the cropped plot to the extent of 200—41=159 lb. of nitrate nitrogen per acre to a depth of 3 feet. We have to set off against this figure the highest value (122 lb.) found for the nitrogen content of the crop at any stage. This figure is for the aerial parts of the crop only. Nitrogen in the roots was estimated at not more than 15 lb. per acre, this being three times the quantity calculated from analysis of roots (0.6 per cent. nitrogen), and the ratio 1 : 11 for dry weight of roots compared with dry weight of aerial substance of wheat grown at Rutherglen, as recorded by Richardson (16).

In the final comparison, then plot "B" was at an advantage in nitrate accumulation during the season to the extent of 159—(122+15) =22 lb. nitrate nitrogen per acre. This evaluation implies the usual assumption that all the nitrogen found in the crop was formed from soil nitrate. Inasmuch as some portion of the crop nitrogen may have come from soil compounds other than nitrate, this assumption may favour the cropped plot. The latter also has a slight advantage by virtue of the 1 or 2 lb. of nitrogen per acre applied in the seed, all of which presumably is available to the crop. Available nitrogen in rain during the period is not considered, because its incidence would affect both plots equally.

TABLE VI.—AMOUNTS OF NITRATE NITROGEN IN THE SOIL OF PLOTS "A" AND "B" TO VARIOUS DEPTHS, AND NITROGEN CONTENT OF THE CROP ON PLOT "A" AT VARIOUS TIMES.

(Figures represent lb. per acre.)

—	—	15.5.30	13.6.30	4.7.30	21.7.30	2..0	4.8.30	11.8.30	18.8.30	25.8.30	1.9.30	8.9.30	15.9.30	29.9.30	20.10.30	10.11.30	4.12.30	29.12.30	8.1.31
Plot "A" (Cropped), Nitrate nitrogen in in soil	Inch. 0–12	135	104	117	70	54	62	28	23	15	9	9	13	12	7	8	13	8	12
	0–18	159	..	143	..	..	..	..	..	26	21	..	..	..	..	..	..	..	19
	0–36	190	..	..	..	..	..	..	..	64	..	..	..	..	..	..	..	..	41
Plot "A" Nitrogen in crop	..	0	3	13	..	36	..	..	70	..	..	102	..	118	119	122	105	106	..
Plot "B" (Bare), Nitrate Nitrogen in soil	0–12	(135)	..	..	106	82	100	111	57	61	61	40	107	..	..	..	..	..	148
	0–18	(159)	..	..	..	..	..	..	..	..	122	..	..	..	..	..	..	..	167
	0–36	(190)	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	200

Discussion.

The figure of 22 lb. of nitrate nitrogen per acre noted above represents the advantage of bare soil over cropped soil at harvest when conditions of comparison were made as favorable as possible for the cropped soil. Plot "B" was a second year fallow which, at seed time 1930, entered its second season without crop at a high nitrate level. During the season, which was one of heavy rainfall, especially towards the close, this plot suffered badly from a combination of deep leaching and disappearance of nitrate in subsoil. These effects were of minor importance in plot "A," because its nitrate supply was rapidly depleted by the crop (Table VI). Efficiency of leaching is undoubtedly greater for the higher nitrate contents, so that plot "B," in spite of excellent nitrate-developing capacity, was able to add to its nitrate nitrogen content during the season only 10 lb. per acre to a depth of 3 feet. Its final surface concentration of nitrate must have developed almost entirely in a period of about a fortnight succeeding the heavy rains of December. This ability of bare Rutherglen soil to accumulate considerable amounts of nitrate in comparatively short periods is in notable contrast to the very sluggish behaviour of cropped soil after the crop has become established.

The disadvantage of plot "B" in holding a high nitrate content during a season of heavy rainfall is well seen by comparison with an adjacent "new" fallow soil, i.e., a plot ploughed from stubble before seed time 1930. This plot added to its nitrate nitrogen content by more than 50 lb. per acre during the season. Judged against this standard, this being a normal fallow, whereas plot "B" is a departure from ordinary practice, the cropped plot "A" is at a disadvantage of about 62 lb. nitrate nitrogen per acre. This result is comparable with that obtained at Rutherglen in 1929, when a difference of 50 lb. per acre, after allowing for the nitrogen in the crop, was found at harvest time in favour of "new" fallow as compared with adjacent cropped soil ploughed from the same stubble field early in the year.

The essential difference between a new and a second year fallow from the present point of view consists in the differing nitrate levels at which they face the rainy season. Leaching of nitrate to subsoils takes place in both cases, but to a relatively greater extent in the soil richer in nitrate (second year fallow). Any considerable concentration of nitrate in subsoil, which occurs only in the case of long-period fallows, rapidly dwindles because of the disappearing effect previously mentioned. Several instances of this combination of leaching and disappearance of nitrate are shown in the data of Table V. The available evidence suggests that nitrate nitrogen in excess of about 10 to 15 parts per million of soil is unstable in Rutherglen subsoils. This effect undoubtedly sets a limit to nitrate accumulation under long continued fallowing, except under light rainfall. It has been stated that there was no consistent evidence of reduction to nitrate or ammonia to account for the disappearance of nitrate in subsoils. Neither was there adequate evidence of its assimilation by heterotrophic organisms to form microbial protein. If such an action had occurred to the notable extent indicated by the nitrate diminution in the 6-12-in. zone, one would have expected increases in bacterial numbers of considerably higher magnitude than is shown by the fluctuations in Fig. 1.

Tables V. and VI. show that the final disadvantage of plot "A" is due to inability to accumulate nitrate after the crop has become established. Interference with nitrate accumulation as the result of crop growth is negligible during early growth. This is shown by the surface development of nitrate in plot "A" in the interval from sowing to 4th July, 1930, and by a comparison of plots "A" and "B" on 21st July, 1930. On this date, as shown by Table VI., an (interpolated) allowance of 30 lb. nitrogen for the crop brings the nitrate total for the surface foot of "A" to 100 lb. per acre, a figure closely comparable with that of the bare plot (106 lb.). Similar comparisons prevail until early September, and, as shown in Table VI., there was very little absorption of nitrogen by the crop after mid-September, so that the final difference is due to the inability of cropped soil to accumulate nitrate in the spring and early summer. It is in these months that Rutherglen fallows in seasons of normal rainfall accumulate most of their nitrate. The numbers of heterotrophic organisms were greater in cropped than in bare soil up to September as well as afterwards. As the greater microbial activity in cropped soil apparently did not materially affect nitrate accumulation up till September, it was unlikely to do so later. This evidence and the fact that the crop was able to secure such a

large proportion of the available nitrate suggest that competition of heterotrophic organisms with the crop for nitrate was not a material factor in this work. Development of these organisms is usually stimulated as the result of crop growth (4, p. 792), and it has been suggested that their utilization of nitrate is one of the causes of depressed nitrate production in cropped soil (I).

On the other hand the present work supports the alternative suggestion (I) that the effect of crop growth is to interfere with the agencies of nitrate production. Development of nitrate in Rutherglen soil was attributed, as the result of this and related work, largely to the activity of Azotobacter in association with a nitrifying flora of normal character. Azotobacter fixes nitrogen from the soil atmosphere in the form of microbial protein. It is considered (15) that such fixed nitrogen readily becomes available, probably by autolysis of the dead Azotobacter cells followed by nitrification. This being so, the differing levels of Azotobacter activity in the two types of plot shown by plaque tests, especially in early spring, is sufficient to account for the comparative inability of cropped soil to accumulate nitrate after the crop has made good growth. This effect apparently persists after harvest, while fallow soil, containing in summer Azotobacter at a high level of activity, develops large concentrations of soil nitrate.

Summary.

A contribution is made to the study of the depressive effect of a wheat crop on the accumulation of soil nitrate. During the 1930 season, periodical evaluation was made at Rutherglen, Victoria, of the amount of available nitrogen in cropped and bare soil, and of the nitrogen content of the crop. The micro-population of the soils was examined in a series of weekly counts. The plots used were shown to be closely comparable in nitrate production prior to the sowing of wheat on one of them.

It was found that there was no appreciable interference with nitrate accumulation in cropped soil during early life of the crop. At later stages comparatively very poor capacity for accumulating nitrate was observed in cropped soil. This led to a disadvantage of cropped as compared with bare soil at harvest time to the extent of about 22 lb. of nitrate nitrogen per acre, after allowing for the nitrogen contained in the crop. The "bare soil" treatment and general conditions of comparison were such that the cropped soil was given every advantage. Compared with a normal bare fallow, the cropped soil stood at a disadvantage of more than 60 lb. of nitrate nitrogen per acre.

The available evidence suggests that this depressive effect of the crop on nitrate accumulation is largely due to interference as the result of crop growth with the agencies responsible for nitrate development in the soil, rather than to any stimulating effect on processes involving assimilation or reduction of nitrate. Development of nitrate in Rutherglen soil is attributed as the result of this and related work chiefly to the activity of Azotobacter in association with a normal nitrifying flora, and it was observed that, especially in the later counts, Azotobacter was in a depressed state of activity in cropped as compared with bare soil. The final disadvantage in nitrate of cropped Rutherglen soil is attributed to interference as the result of crop growth with the activity of Azotobacter, after the crop has become well established. Apart from this effect on the free-living nitrogen-fixing organisms, crop growth stimulated general microbial activity.

Disappearance of nitrate within subsoils is noted, and its bearing on the behaviour of long-period fallows discussed. Nitrate appears to be unstable in Rutherglen subsoils in concentrations greater than about 10 to 15 parts of nitrogen per million of soil. No adequate explanation in terms of assimilation to form microbial protein or denitrification to give ammonia or nitrite could be found.

Indications from Winogradsky soil plaques are in accordance with the chemical nature of Rutherglen soil, and with the results obtained in fertilizer trials with cereals by the use of phosphate, potash, and lime.

Acknowledgments.

The writers wish to acknowledge the valuable help given by Professor Woodruff, of the School of Bacteriology, University of Melbourne. The chemical work was facilitated by the able laboratory assistance given by Mr. J. K. Skene, Department of Agriculture, Victoria. The thorough work of Mr. H. L. Hore, of the State Farm, Rutherglen, whose help was made available by Mr. H. A. Mullett, Agricultural Superintendent, Department of Agriculture, Victoria, formed an essential part of this investigation, being applied to management and sampling of the plots.

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Werribee Research Farm

(*Continued from page 472*).

shows that an annual application of 4 cwt. per acre is payable. Chemical analyses have shown an enhanced feeding value from top-dressing these pastures with superphosphate, and the liberal use of this fertilizer permits sustained high production in the growing season, and promotes better growth in the winter period.

Rotational Grazing.

In 1929 a 10-acre paddock was subdivided to test the influence of two different systems of grazing on carrying capacity and condition of the pasture. In one portion, 5 acres is divided into two, and each half is grazed alternately for ten days. The other portion of 5 acres is subdivided into ten ½-acre lots, and each of these is grazed for two days in rotation.

The pasture on the area is sixteen years old. Perennial Rye grass and Kentucky Blue grass were spread throughout, while Cocksfoot was fairly well represented. White clover, Strawberry clover, and Subterranean clover were well distributed. The manurial treatment was an autumn dressing of 2 cwt. of superphosphate. Before commencing the tests the whole area was grazed short.

The most notable feature of the tests has been that under the controlled grazing, permitted by the subdivision, the carrying capacity has been surprisingly high. The sheep have been maintained in prime condition, and up to fourteen per acre were grazing the small areas during the summer, and in July eight sheep per acre were carried comfortably.

The sheep have been weighed at intervals of ten days and their progress recorded. Botanical surveys are made at intervals and a method of sampling by clipping is being used. It is hoped this will give a measure of growth, the seasonal variation, the amount eaten by the sheep, their preference for particular species, and the difference in the growth of the pastures under the two systems of grazing.

The sheep at present on the plots are maiden ewes (mixed crossbreds, dropped about September, 1930). They were introduced to the tests as weaners on 2nd April, 1931, and the number carried has been varied according to the amount of feed offering. In the winter of 1931 the 10 acres carried 108 sheep, and the number reached 200 in the summer. During the last winter, 80 sheep (the same but a year older) were carried, and have made slight gains in weight. These 80 sheep have been on the plots continuously since April, 1931.

The average number carried on the small plots for 371 days ended 6th April, 1932, was 15.03 sheep per acre, and on the larger plots 14.16 were carried. The sheep grazing on the ten ½-acre plots gained 2,814 lb. of live-weight, and those on the two 2½-acre plots 2,619 lb.

The total area of irrigated grasses now established on the farm is approximately 400 acres, and contains the following mixture of grasses and clovers:—

English rye grass	...	12 to 14 lb. per acre.
Cocksfoot	...	3 to 5 lb. per acre.
Alsike clover	...	1 to 2 lb. per acre.
Red clover	...	1 to 2 lb. per acre.
White clover	...	1 to 2 lb. per acre.
Strawberry clover	...	1 lb. per acre.
Subterranean clover	...	1 to 2 lb. per acre.
Totals	...	22 to 27 lb. per acre.

The first mixture, i.e., 20 lb. per acre, is usually ample, provided the soil conditions at seeding are satisfactory.

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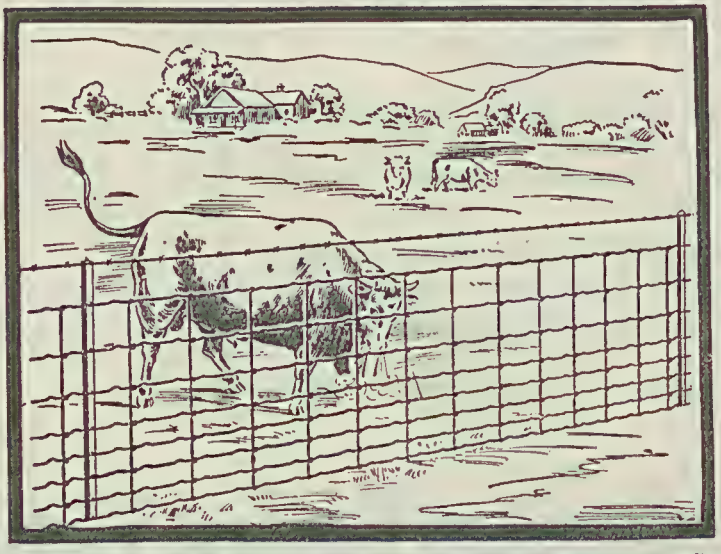

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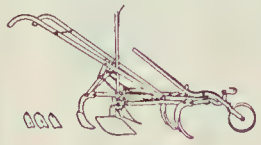

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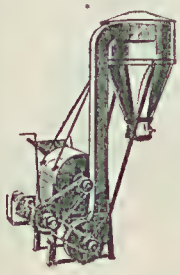

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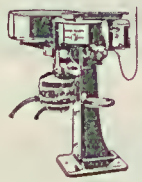

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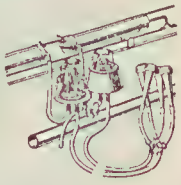

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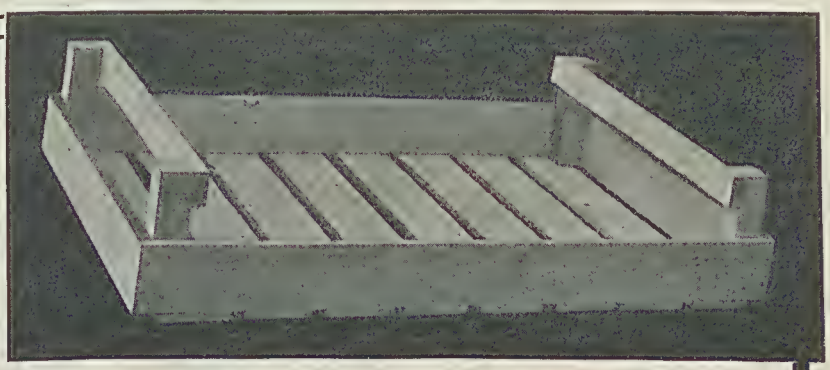

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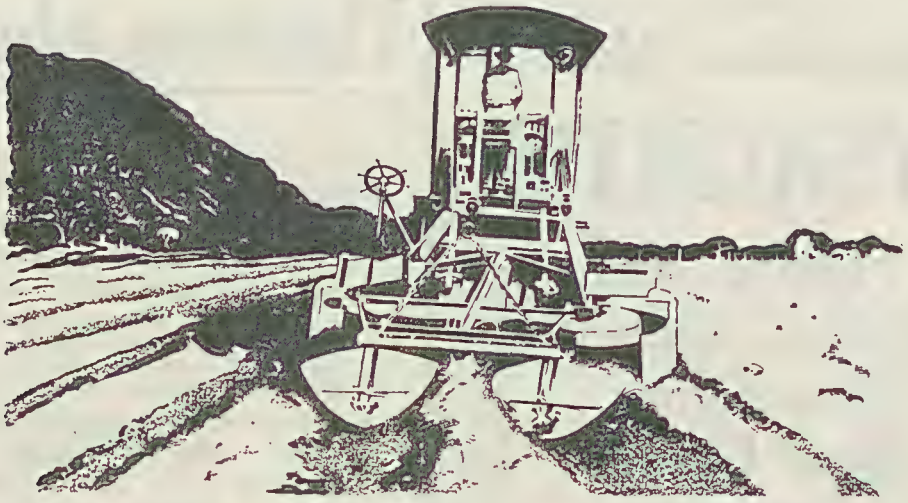

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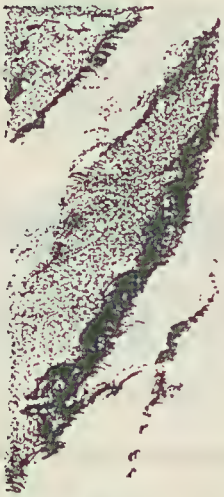

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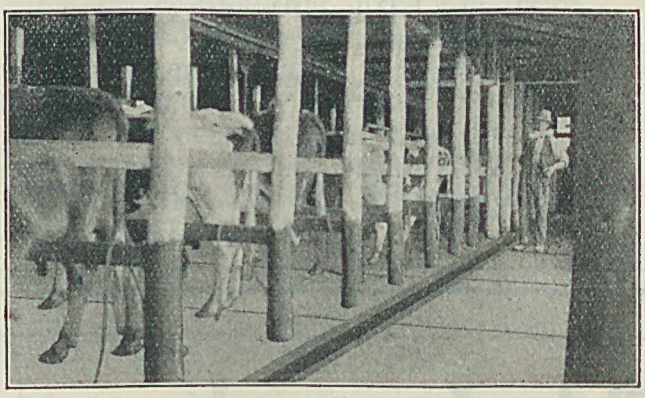

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